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EGG PARASITES AND THEIR RELATIVES.

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(*With a Tinted Plate.*)

ALMOST every one who is engaged in experiments on the development of the ova of fishes, at the present moment quite a fashionable employment, complains that they are subject to the attacks of some parasite, which effectually destroys their vitality.

Various parasites indeed occasionally infest them, such as green confervæ, belonging to the genus *Œdogonium* and others; but there is an especial group of organisms variously assigned to Fungi and Algæ, which are notoriously antagonistic to animals, especially those of aquatic habits, in a low stage of vitality. Flies are attacked by them while still alive, and so are our aquatic mollusca, but not only these smaller beings, but fish of considerable size often fall a prey to them, as is well known to those who have aquaria, and as we have ourselves witnessed at the London Zoological Gardens, and elsewhere. It is one or more of these organisms which attack the ova of our trout, salmon, and char, and therefore a few words about them at the present moment can scarcely be unacceptable.

It is now more than forty years ago since these productions were tolerably well characterised, and one of their most prominent features detected; but it is only of later years that they have been thoroughly investigated. Some of the group are parasitic on confervæ and other aquatic plants, but we shall confine our remarks to the genera *Achlya*, *Saprolegnia*, *Pythia*, and *Aphanomyces*, so far as they affect animal substances.

Gruithuisen appears to have been the first person who observed in the clavate tips of the threads of one of them, *Saprolegnia ferax* (Figs. 1—6), a multitude of minute spore-like bodies, which escaped from them and moved about when free like Infusoria. This observation, on which the genus *Sapro-*

legnia was first established by Nees von Esenbeck, has been now extended with certain modifications to the whole group; and on this account, in addition to their aquatic habits, these plants have been associated with the Algæ, though their appearance and habit are rather those of some of the moulds. Carus, however, in investigating a mouldy appearance which arose on a dead salamander, having immersed half in water and kept the other half moist in air, obtained from the latter an undoubted species of Mucor, while from the former he obtained *Achlya prolifera*, Nees (Figs. 10—12). This was taken at the time as a strong argument for the instability of the lower plants, while in truth it was only one amongst many proofs of a fact which was then unknown, but has since been amply manifested, that in these lower plants there is a duality or plurality of modes of fructification. Indeed, though the active spores, moving about with one or more lash-like appendages, resemble exactly the reproductive bodies which are so common amongst Algæ, there is now evidence amongst moulds, as in the genera *Peronospora* and *Cystopus*, and still more amongst the *Myxogastres*, that there are active spores amongst true Fungi. The difficulty, therefore, in great measure, ceases, and I have not a doubt left in my own mind about the subject, while I consider my remarks in the introduction to *Cryptogamic Botany*, which have been called in question, fully confirmed.

Correct information as to the structure of these curious parasites has been obtained but slowly, and as it is scattered up and down amongst a variety of journals, it is proposed to give here a sort of *précis*, without any pretensions to novelty. The most complete account is that by Pringsheim, in his *Journal of Scientific Botany*.* His definition of three of the genera to which these animal parasites are referrible is here given nearly in his own terms, to which is added a fourth, *Aphanomyces*, proposed by De Bary.

Saprolegnia, Nees v. Esenb.—Infusorioid spores formed in the interior of the sporangia, and immediately after their formation isolated and active without any previous membrane. New sporangia formed by the repeated protrusion of the basal membrane into the old sporangium. Oögonia containing numerous resting spores. (Figs. 1—8.)

Achlya, Nees v. Esenb.—Infusorioid spores formed in the interior of the sporangia, but after their formation collected in a head at the point of issue, and clothed with a membrane. The basal membrane of the sporangia forming lateral sporangia by protrusion at the base of the primary sporangia. Resting spores numerous in the Oögonia. (Figs. 10—14.)

* Jahrbucher fur Wissenshaftliche Botanik herausgegeben von Dr. N. Pringsheim, 1857 and 1589.

Pythium, Pringsheim. — Infusorioid spores formed at the orifice of the sporangia from their ejected contents, not surrounded by a membrane. Basal membrane neither prolonged into the cavity of the sporangium nor bursting out laterally. Oögonia containing a single resting spore. (Figs. 14—16.)

Aphanomyces, De Bary. — Infusorioid spores formed in a single row in long cylindrical tubes, collected in heads after their discharge, and acquiring a membrane before becoming free. Resting spores single in the Oögonia. Antheridia formed from the swollen tips of lateral branches. (Figs. 17—20.)

The parasite I have more especially seen on fish eggs belongs to the first genus, but as it has produced sporangia only, it is scarcely possible to speak positively as to the species, though I believe it to be referrible to *Saprolegnia ferax*.

To make this history more intelligible I will describe one or more species of each genus, in the course of which the technical terms used above will appear more clear.

The first appearance of *Saprolegnia monoica*, as indeed also of *S. ferax*, is that of delicate white or greyish, nearly equal, simple or slightly-branched threads, without any joints, radiating in every direction, and containing a grumous granulated mass. The tips of these threads gradually swell, and after a time a septum is formed at the base, after which the contents are collected into little pellets, each of which, at length, is separated from the rest, and becomes an ovate spore (Fig. 3), which escapes by a little aperture at the tip, and is furnished with one or two delicate thread-like appendages, by means of which it is able to move about like an infusorial animal with great rapidity. After a short time motion ceases, and the spore germinates and produces a new plant. (Fig. 4.)

After the sporangium is exhausted the septum at the base becomes convex, pushes forward (Fig. 2) into the vacant cavity, which it more or less completely fills, and produces another crop of spores, sometimes projecting through the aperture of that which was first formed. This process is repeated a third or even a fourth time till the powers of vegetation are exhausted.

Now, however, a second form of fruit (Fig. 5) appears. A form which has been called an Oögonium, because it produces spores which are quiescent and dormant for a time like eggs, and not furnished with motile appendages. Lateral branches are given off for their production, which terminate in large globose sacs, which, like the sporangia, are not at first separated by any septum. One, however, is at length formed, and the membrane becomes pierced with numerous apertures. Meanwhile other branches (as in *S. monoica*) spring up in their neighbourhood, the tips of which swell, and at length become

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antheridia filled with granules, which seem to have the power of impregnating the contents of the Oögonia (Fig. 7). Processes from the antheridia enter the apertures (Fig. 6) in the walls of the Oögonia, the contents of which are soon transformed into numerous large globose resting spores. These like the others have the power of propagating the plant, and, like the resting spores of some other Algæ, are able to exist some months without vegetating, though occasionally they germinate *in situ*. As regards the vegetation in general, it proceeds with the utmost rapidity, so that constant attention is necessary to follow out the several phases satisfactorily.

In *Saprolegnia ferax* the first stage is precisely the same, but there are no lateral branches by the contents of the tips of which the Oögonia can be impregnated (Fig. 5). This is the case also in some other species, in which impregnation takes place by means of antheridia produced within the Oögonia, or bodies resembling the Oögonia in form, or by antheridia produced on certain threads, which after a time become free, and attach themselves to the Oögonia, as in some genera of Algæ, where they are called by the Germans Männchen, a term equivalent to Homunculi. The different species are, however, not at present perfectly characterised, and Pringsheim, who has paid so much attention to these productions, and to whom we are indebted for the greater part of our information, does not profess to have placed every particular beyond doubt.

In *Saprolegnia dioica*, however, he has shown that, after the power of forming sporangia has been exhausted, a new crop of threads springs up from the matrix, destined to produce the antheridia. The upper portions of these threads (Fig. 8) becomes septate, and commencing with the uppermost joint the contents become organized and re-transformed into myriads of minute bodies (Fig. 9), each of which bears a single thread-like appendage. These bodies are ejected from a terminal papilla, but in the succeeding joints the point of egress is lateral. They do not germinate like the infusorioid spores, and, as there seems to be no other mode of impregnation, it is conjectured that they pass through the apertures of the Oögonia, and thus vivify the resting spores.

Saprolegnia ferax is extremely common on flies in autumn, and may at almost any time be procured for examination by simply placing a few of the languid flies which are so common towards the close of the year in water.

Achlya prolifera (Figs. 10—12) will, however, sometimes appear on the same matrix, and possibly on other animal substances also.

The first stage of this plant is very like that of *Saprolegnia*, at least up to the formation of the first septum at the base of

the clublike end of the threads. The contents, however, of the joint when differentiated are not at once discharged as perfect infusorioid spores, but are collected in a globular head (Fig. 10) at the point of issue, where, after a time, each individual acquires a membrane, through which (Fig. 11) the spore at length bursts and moves about by the means of two appendages (Fig. 12).

The portion below the effete joint does not, as in the former case, push forward into the cavity, but bursts laterally through the walls, and as this process is repeated we have a forked thread.

The Oögonia are formed, as in *Saprolegnia ferax*, without any lateral branches, and, as in that plant, its walls are perforated with numerous holes. The antheridia in this species are, we believe, unknown, but in a closely allied species, *A. dioica*, they are produced, as in *Saprolegnia dioica*, on distinct threads (Fig. 13) thrown up from the base of the tuft after the sporangia have been formed. The threads are articulated in the same way, and, commencing with the upper joint, the contents are transformed into a number of globose antheridia, each of which gives rise to a quantity of uniciliate bodies (Fig. 14), which escape from the common aperture, leaving the mother cells behind. The process is repeated till it extends to four of five joints. The minute bodies do not germinate, and, therefore, as in the case of *S. dioica*, there seems little doubt about their functions.

We next come to *Pythium*, one species of which, *P. monospermum* (Figs. 14*, 16), grows on dead insects in water.

In this species the sporangia, which are produced on short lateral branches, are solitary and extremely long (Fig. 14*), with one, or sometimes two, shorter delicate appendages at their base. The contents ooze out and form a globular mass (Fig. 15) at the apex, in the centre of which the infusorioid spores are formed. The Oögonia are small and globose, and with or without a terminal thread or papilla; lateral threads are given off in their neighbourhood, the tips of which swell into antheridia and penetrate the Oögonium through one of its apertures by means of little rootlike processes, as in *Saprolegnia monoica* (Fig. 7), thus giving rise to a solitary resting spore (Fig. 16).

We have still to notice the fourth genus, which has been proposed by De Bary under the name of *Aphanomyces* (Figs. 17—20), a name which seems to imply a close affinity with Fungi, if not an immediate relation. Three of the species described grow upon insects in water. This genus is distinguished from the last by the peculiar mode in which the infusorioid bodies are formed. Each is produced separately from the contents of the thread, and as one escapes another comes forward from behind

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(Fig. 17). When all have emerged each gradually acquires a separate membrane (Fig. 18), from which it ultimately escapes, moving about with one or two cilia (Fig. 19). The Oögonia are globose. Impregnation takes place by means of antheridia produced at the tips of lateral branches, as in *Pythium*. In *Aphanomyces stellatus* the Oögonia are covered with projecting papillæ (Fig. 20). In *A. scaber* they are much less rough, while in *A. lævis* they are quite destitute of warts. A single resting spore only is formed in each sac.

It remains only to notice a curious circumstance that, in an unnamed species of *Saprolegnia*, Pringsheim has occasionally found a single echinulate body formed within the Oögonium, reminding one at once of the similar bodies observed by Caspary and others, which are formed as a second kind of fruit in *Peronospora*. Cienkowski has also observed something very similar. This appears to be an additional argument for the reference of these curious bodies to Fungi. Attention also may be called to the close resemblance of the process of impregnation in *Saprolegnia dioica* to that which Hofmeister is said to have observed in Truffles (Pringsh. Jahr. Band 2), and still more to De Bary's observations on *Cystopus* and *Peronospora*, in the 20th volume of the fourth series of *Annales des Sciences Naturelles*, just published, and of which I shall hope shortly to give a report in the INTELLECTUAL OBSERVER.

If I am asked to propose a remedy for the disease, I am unable to make any plausible suggestion, as the substances which might prove an impediment to the production of these plants may prove equally detrimental to the eggs or fish which it is wished to protect. I can only suggest that a weak solution of hyposulphite of soda should be tried in the case of a few eggs, and, if it succeeds on a small scale, the experiment might be easily extended. No one would be rash enough to risk any great loss on a first experiment.

The following are the principal treatises which have been examined in the preparation of this paper:—Gruithuisen in Act. Leop. 1821, p. 450, t. 38. Carus in Act. Leop. 1823, t. 58. Pringsheim, Nov. Act. 1850, t. 46—50. Thuret Recherches sur les Zoospores des Algues, 1851. De Bary Beitrag zur Kenntniss der Achlya prolifera Botanische Zeitung, 1852. Cienkowski Algologische Studien Bot. Zeit. 1855. Pringsheim in Pringsheim Jahrb. Band 1, Heft 2. Pringsheim Band 2, Heft 2. De Bary in Pringsh. Jahrb. Band 2, Heft 2.

DESCRIPTIONS OF FIGURES.

Figs. 1—6. *Saprolegnia ferax*.—1. Group of threads with sporangia in different stages of growth, magnified. 2. Forma-

tion of second sporangium. 3. Infusorioid spore highly magnified. 4. Do. do. in germination. 5. Oögonia in various stages, magnified. 6. Portion of wall to show the apertures.

7. *Saprolegnia monoica.*—Oögonium with antheridia, one of which has penetrated the cavity by means of a rootlike process.

8, 9. *Saprolegnia dioica.*—8. Thread magnified, producing spermatozoids. 9. Spermatozoid highly magnified, killed with iodine.

10—12. *Achlya prolifera.*—10. Tip of thread, showing the infusorioid spores making their way to the tip of sporangium, and new sporangium formed at the base. 11. Infusorioid spores surrounded by membrane, and two empty cases, highly magnified. 12. Perfect spores free, highly magnified.

13, 14. *Achlya dioica.*—13. Tip of thread containing antheridia, from some of which the spermatozoids are escaping. 14. Spermatozoids, killed with iodine, highly magnified.

14*—16. *Pythium monospermum.*—14.* Thread with sporangia magnified. 15. Infusorioid spores collected at tip of a sporangium, highly magnified. 16. Oögonium with antheridium.

17—20. *Aphanomyces stellatus.*—17. Thread showing the spores making their way, one by one, to the tip. 18. Spores surrounded by membrane and empty cases. 19. Do. free. 20. Oögonia with antheridia.

The figures are all borrowed, with a single exception, from the above-mentioned memoirs.

PHOTOGRAPHY—ITS HISTORY, POSITION, AND PROSPECTS.

PART I.—HISTORY OF PHOTOGRAPHY.†

BY J. W. M'GAULEY.

In treating of a science which, although the creation of but a comparatively recent period, has become so extensive as to be dependent on an immense number of principles, to include a great variety of processes, and to be scattered over a vast body of literature in every modern language, it will be impossible, even in a paper of unusual dimensions, to give more than a glance at its past history, its present position, and its future prospects. It is not our object to teach the Art of Photography, we propose merely to trace its progress from its first glimmerings to its now wondrous development; to give a

† The remaining parts will follow at early dates.

short general view of its most important processes; to explain the most interesting of the principles on which its manipulations are founded; and finally to notice some of the accidents and failures to which it is liable. Although it is almost impossible to keep these perfectly distinct, it is more convenient to treat them separately.

Photography (light writing) enables us to produce pictures by means of the sun's rays, nevertheless its designation has not been happily chosen. Niepce very early suggested the term *Heliography* (sun writing), which would be far less open to objection; but it was not adopted: and the name, like many others which are unfortunately found in science, and were formed under the dangerous guidance of imperfect knowledge, is likely to maintain its position. It is not improbable, however, that it may yet be appropriate, since the day appears not very remote when even the various coloured rays will be compelled to leave their characteristic and permanent impress, and the photograph will become a picture in the truest sense of the word.

History of Photography. Photography originated in, and its chief processes still are—as perhaps they always will be—founded on the fact that the salts of silver are blackened by light. This, although so recently utilized, is not a new discovery. So early as the middle of the fifteenth century the alchymists had observed the blackening of fused chloride of silver; and they even considered the "sulphurous principle" of light, as they termed it, one of the chief agents through which nature received her variety of form. This extraordinary property of light continued, at least from time to time, to arrest the attention of philosophers, but the progress of its investigation was long and tedious. In 1777, Scheele concluded from his experiments that the dark tint produced was due to "reduced silver"; and he remarked that the violet acted more energetically than any other ray. In 1801, Ritter observed that a silver salt was blackened in a space beyond the violet of the spectrum, and that the red ray restored the reduced chloride. Then, it was discovered that the action of light was not confined to argentiferous compounds; Wollaston, in 1802, ascertained that cards moistened with tincture of gum guiaiacum acquired a green tint in the violet ray, but lost it in the red. In 1810, Seebeck noticed that the tints produced by light on chloride of silver were different with the different coloured rays; violet rendering it violet; blue, blue; yellow, white; and red, red. This was the first approximation to *Heliochromy*. Berard perceived that, when the rays of the spectrum, from the green to the extremity of the red, were concentrated by a lens, chloride of silver, exposed in the focus for more than two hours,

suffered no perceptible alteration, although the light was too brilliant for endurance; but that it was blackened in six minutes, when it was exposed, in a similar way, to the rays between the green and the extremity of the violet. Philosophers are now aware that the solar spectrum in reality consists of three spectra, possessing very different properties, partially, but not uniformly, superimposed—a luminous, a calorific, and an actinic, photographic effects being due to the last; and that the luminous consists of a yellow, a red, and a blue spectrum, similarly superimposed. Whether the calorific and the actinic also are compound, our present knowledge does not enable us to decide.

The important circumstance of the action of light on a salt of silver having once attracted attention, such a modification of the effect as would result in a picture was but a step, though an important one. This step is due to the combined ingenuity of Wedgewood, the son of the celebrated porcelain manufacturer, and Sir H. Davy, the illustrious chemist. The effects they produced excited admiration, but their pictures gradually changed into mere blackened surfaces. The knowledge of one simple fact alone was required to give permanence to their productions; but that fact was not discovered until long afterwards. These achievements of Wedgewood and Davy had been, in some degree, anticipated more than two centuries previously; since Fabricius, in a work on metals, published in 1566, asserted that a lens produced on chloride of silver an image in which the bright parts of objects formed dark shadows, and their dark parts lights—that is, a "negative picture," the lights and shades being reversed. Such were the pictures of Wedgewood and Davy, since they were unable to obtain a positive by transmitting the light through a negative. At this stage, the camera obscura naturally suggested itself as a valuable aid to photography; but, when Wedgewood made the trial, he found that too long an exposure to light was required, if it was used. The solar microscope, however, was found to be available for the purpose; but he usually employed the direct rays of the sun, transmitted through the engraving, or other object which it was desired to copy. Wedgewood discovered that the chloride was more sensitive than the nitrate of silver, and that both were more sensitive in the moist than in the dry state.

Little or no further progress was made for some time; but at length the grand difficulty was surmounted; Niepce and Daguerre succeeded in *arresting* the action of light. Nicephorus Niepce was born at Chalons-sur-Saône, in 1765. In his early years he had been in the army, but in 1814 his attention was accidentally turned to photography. Seeking a substitute for lithographic stone, he observed that bitumen was rendered of

a greyish colour by the action of light; and that if spread as a thin coating over a metallic plate, and exposed to the light, it was rendered soluble in essence of lavender, wherever the light had acted. He advanced then step by step to important results, Daguerre being, during the latter portion of his career, the partner of his researches. But he did not himself reap the reward of his labours, since he died in poverty in 1833, having dissipated his patrimony in scientific investigations. When, however, in 1839, the discoveries made conjointly by him and Daguerre were purchased by the French Government, and given to the world, his son was not forgotten. Louis-Jaques-Maudé Daguerre, a celebrated French artist, was born at Corneilles, in 1789. His early life was passed in stormy times, but this did not prevent him from devoting himself to his profession and becoming very eminent as a scenic decorator and a painter of dioramas. While attending a course of chemistry under Charles, with the purpose of calling that science to the aid of his pencil, he was struck by a remark made by the lecturer, when he exhibited to his audience an image produced by means of a salt of silver—"it is the sun that has drawn this portrait." Again and again Daguerre repeated these words to himself, but each time he was obliged to add, "it does not last." He was resolved, however, to give it permanence; and, in the researches he undertook for the purpose, availed himself of the improvements which had lately been made in the camera. He did not die until 1851, long after his labours had been crowned with success.

The attempt to arrest the action of light had occupied the attention of Niepce from 1814 to 1824, with but little result. Towards the close of this period, his brother, a colonel in the French army, while making some purchases of Chevalier, the eminent optician, happened to remark that Niepce had succeeded in fixing the image produced by the camera; but Chevalier discrediting the assertion, paid no attention to it. And when, some days after, Daguerre called upon Chevalier, and announced a similar discovery, he looked upon it merely as a continuation of the same pleasantry. But at length, finding that Daguerre was in earnest, he gave him such information regarding Niepce, as produced a correspondence between the two experimentalists, that ended in their becoming partners; and before the close of 1827 considerable progress was made by them in the attainment of an effective mode of fixation.

Niepce's object was, originally, the multiplication of images; which he sought to accomplish by coating a metallic plate with bitumen, exposing it to the action of light, dissolving off the coating where the actinic influence had rendered it soluble, and then corroding with nitric acid those parts which had thus

been denuded. This process was ultimately modified so as to be applicable to photography. Daguerre also used a metallic plate; but his object was to form a single picture directly upon it. The last step made by Niepce was the substitution of iodine for a resinous coating, which diminished the time required for exposure from hours to minutes. He died soon after, and his son Isidore became the partner of Niepce. In 1839 the fruit of all their joint researches was given to the world. Twelve days after the Chamber of Deputies had voted their well earned rewards to those who may be said to have created photography, Daguerre lost, by a conflagration, the results of all his labours as an artist; but the reputation he had acquired enabled him to recover from the effects of this calamity, and he thenceforward devoted himself to philosophy.

At first, the Daguerreotype process was extremely slow, an hour being required for a portrait; but the use of bromine, introduced by Goddard in 1840, and of other accelerating materials, greatly abbreviated it. The removal of the undecomposed silver salt, by means of hyposulphite of soda, constituted its most important feature, as it was this which prevented the darkening of the picture. But Sir J. Herschel also discovered this important property of the hyposulphite, though unknown to Daguerre. The Daguerreotype process has, for several reasons, been practically abandoned.

It is a curious circumstance that, while Niepce and Daguerre were occupied with their experiments, a young man who was quite unknown to Chevalier showed him some photographic positives on paper, expressing his conviction that with a better apparatus than he possessed he would produce still greater results, but avowing his inability to purchase one. He left some of the material he had used that it might be tested by experiment, but neither Chevalier nor Daguerre were able to accomplish anything with it. He never returned, and remains unknown. But for his poverty he would perhaps have been the successful rival of Niepce and Daguerre.

Six months before the Daguerreotype process was published, Fox Talbot, who had been engaged in his researches since 1834, and had succeeded in fixing the picture, communicated to the Royal Society his photographic discoveries, and immediately after made known his method of preparing sensitive paper. He was betrayed by one of his assistants, who sold the secret of his process to a photographic society at Lille, where some good pictures were produced by means of it. Talbot was the first who successfully used paper rendered sensitive with chloride of silver. He observed not only that different papers similarly prepared vary in sensibility from very slight causes, but that some portions of the same paper, even when most

carefully prepared, may be found quite insensible. He claimed a patent right in the use of gallic acid as a most effective sensitizing agent, but Sir J. Herschel had already attempted to apply it to that purpose, and Read had actually succeeded in doing so. In 1840, Sir J. Herschel had found that photographic effects might be produced by means of any chemical agent whose constituents are not firmly combined. And, in 1841, Claudet discovered that certain substances possessed the property of imparting rapidity, that is, of diminishing the time required for exposure to the action of light.

It has been asserted that Watt obtained pictures with both silvered plates and paper; and specimens of photography on these substances, said to have been produced by him, have been exhibited.

Attempts were soon made to obtain substitutes for paper, which is exposed to many and serious defects, particularly when used for the production of negatives. M. Niepce de Saint Victor was very successful in this, as he has since been in other branches of photography. Like his uncle, the colleague of Daguerre, he was in the army before he became an experimentalist. In 1842, being a lieutenant of dragoons in garrison at Montauban, he amused himself with scientific researches. It happened that the government resolved in that year to change the colour which had hitherto characterized the uniform of the regiments of dragoons, for another. But where was Mareschal Soult to find the money required for this alteration? Hearing of Niepce as a young officer who was likely to carry out his plans with the required economy, he sent for him. On arriving in Paris, Niepce showed that a brush dipped in a certain fluid would produce the required transformation. He received five hundred francs for his ingenuity, which saved the government a thousand times as much, and a gracious letter. While in Paris, he was greatly struck by the photographs which met his view on every side, and, coming to the conclusion that there only could he make experiments with full effect, he managed to have himself transferred to the municipal guard of that city, and established his laboratory in the barrack of the Faubourg St. Martin. Here he made discoveries which have inscribed his name in the annals of photography. In the conflagration of the barrack, after the flight of Louis Philippe, all his specimens and apparatus perished, but he was soon more favourably circumstanced than ever. The provisional government made him captain of the Republican Guard, and, afterwards, the Emperor Napoleon appointed him Commandant of the Louvre. In 1847 he presented a memoir to the Academy of Sciences on a means of obtaining pictures on glass. Starch was the first substance he employed as a

coating. He afterwards adopted albumen, which he preferred to gelatine, because less easily soluble in water.

In 1838, Ponton, of Edinburgh, discovered the insolubility produced in bichromate of potash by light. In 1853, Talbot found that organic matter in contact with it became insoluble in the same circumstances. In 1855, Poitevin applied this fact to lithography. In 1859, Asser, of Amsterdam, invented the mode of "transference," founded on the facility with which printer's ink spread on gelatinized paper, may be removed by water; and in the same year, Gibbons discovered a method of producing the picture from a negative directly on the stone.

Many persons claim the merit of suggesting waxed paper, as a very transparent material for negatives. Many, also, are mentioned as having first used collodion, the applicability of which to photography was made known simultaneously in France and England, in 1851. In that year, a report became prevalent that a clergyman of the United States, named Hill, had found out a means of reproducing the natural colours of objects. Incredible sums were realized by the sale of books, which appeared in succession—being paid for by the subscribers in advance, and which, it was promised, would reveal the important secret, but they gave no clue whatever to it. Various efforts were then made to obtain the desired information by energetic means, but without success; and the "Hillotype" sunk at length into oblivion. Nevertheless, the reproduction of colour is not impossible, and "Heliochromy" has already advanced so far as to constitute a recognized though, as yet, little more than a *future* branch of photography.

We are indebted to M. Edmond Bequerel for a knowledge of the fact that a silver plate acquires, by immersion in a solution of chlorine, the property of reproducing the colours of the spectrum. The effect, however, is but transitory; since it vanishes at once under the influence of white, and gradually under that of coloured light. Fixation, therefore, so long the desideratum of photography, is at present the great object of search in heliography. But something has been done already, even in this direction. In 1861, Niepce de Saint Victor announced that, if the problem of fixation was not solved, there was reason to expect its solution. In his laboratory at the Faubourg St. Martin, he made the important discovery that the different colours give rise to absorption of the vapour of iodine, in different degrees. He found also that, when a silver plate is plunged into a solution of chlorine, the strength of which is regulated, any particular colour may be made to appear on the plate. The least possible quantity of chlorine allows the reproduction of yellow; progressively larger quantities, give green, blue, indigo, violet, red, orange—the last, appearing

only in a saturated solution. He observed that certain metallic chlorides, particularly chloride of copper and sesqui-chloride of iron, give coloured images still more readily than a mere solution of chlorine. Portraits artificially but skilfully coloured have been sold as the pure products of heliochromy; no coloured photograph has, however, as yet been produced by it.

Photography has already become of the highest importance, its votaries are scattered in tens of thousands over every part of the world; it has been pressed into the service of every art, science, and manufacture. Nor are its uses confined to the requirements of tranquillity and peace; it has been made a portion of the appliances of war, and on a rather considerable scale, as appears from a paper read before the Photographic Society of London, in December last.* The extent to which it has caused an increase in the consumption of chemical substances may be conceived from the fact that, at Frankfort, during the year 1862, 5400 German pounds of the finest grain silver, worth 163,428 thalers (about £36,000), were devoted to the manufacture of nitrate of silver alone [*Photographisches Archiv.* Sep. 1863].

OZONE AND OZONE TESTS.

BY E. J. LOWE, F.R.A.S., F.G.S., ETC.

Ozone is a subject that has attracted a large amount of interest within the last few years. Schonbein, in making the important discovery of ozone in the atmosphere, added fresh work to all meteorological observers, and their labours have thrown some light on the subject. To those who have no knowledge of this new property of the air, it may be said that, if a piece of paper be dipped into, or coated over, with a solution consisting of starch, iodide of potassium, and distilled water, dried and then exposed to the air, it becomes more or less coloured, according to the amount of ozone present at the time. Dr. Moffatt, who was the first to take up this subject in England, has rendered great service to science, and his tests have been almost universally adopted by English meteorologists for a number of years; and although an extended series of experiments has convinced me that the tests I am now making are purer, and better adapted for a thorough insight into this chemical property of the air, nevertheless our warmest thanks are due to Dr. Moffatt for his valuable labours in this branch of science. Before turning to ozone tests, we will say a few words on ozone itself.

* *Photographic Journal*, Dec. 1863.

Locally it varies considerably, being most abundant near the sea and in high mountainous districts, and least so in cities and large towns. There is more ozone at Silloth, a seaport town in Cumberland, than in any other British station; whilst in Scotland the amount is very great at Braemar, a mountainous town near the Queen's residence at Balmoral. On the other hand, at Manchester and in London very little exists. Then, again, there are periods with much ozone, and periods with scarcely any. An instance of this occurs in the month of January just passed; up to the 19th scarcely any ozone was present, whilst from the 19th to the end of the month the amount was considerable.

No doubt, circumstances act for or against the development of ozone, at one time augmenting the amount, and at another diminishing it. Chemical action increases with an increase of heat, and diminishes with an increase of cold; to this cause is probably owing the absence, more or less, of ozone in frosty weather. Moisture to a certain extent is favourable to chemical action, yet an excess of moisture acts in the opposite direction; there is less ozone with a very dry air, and still less with one completely saturated with moisture. It must be borne in mind that we frequently have the air saturated with water, whilst the atmosphere never approaches perfect dryness; on the driest days a considerable amount of water is present in the air. There is a striking difference in different directions of the wind, for there is least ozone with a N.E. wind, and most with one between S.W. and S.S.W.; the latter contains air much charged with moisture, whilst the former is more or less dry; then, again, as a rule, the S.W. wind is brisk, whilst the N.E. wind is sluggish. An increase in the pressure of the wind, which is synonymous to an increase in the velocity of the air, is attended with an increase in ozone, as registered on the test-slip; yet it does not follow that there is an actual increase, because if the same amount is present to-day as yesterday, and if to-day the velocity of the air is five times greater than yesterday, it will be apparent that five times the amount of air charged with ozone must pass over the test-slip, and this will, no doubt, increase the colour of the test.

It seems somewhat singular, that the lower the barometer falls the more does ozone develop itself; that at a pressure of 29 inches there is considerably more ozone than with one at 30 inches. Let us consider what this difference means: when the barometer is at 30 inches, the air is capable of balancing a column of mercury 30 inches in length, whilst when it is only 29 it can only balance one of 29 inches; with the barometer at 29 inches, a cubic foot of air at a temperature of 10° weighs about 573 grains; at 30° about 549 grains; at 50° about 526

grains; at 70° about 504 grains, and at 90° about 482 grains; with the barometer at 30 inches, below the freezing point, it will be about 20 grains heavier; at a temperature of 50°, 18 grains heavier; and at 90°, 16½ grains heavier. Supposing the atmosphere to be completely saturated with moisture, the weight of vapour in a cubic foot of air, at a temperature of 30°, will be 2 grains; at 50°, 4 grains; at 70°, 8 grains; and at 90°, nearly 15 grains. The amount of vapour differs, according to the difference between the wet and dry bulb thermometer; taking the greatest difference, or driest point at each temperature, the weight of vapour at 30° will be 1 grain; at 50°, 2 grains; at 70°, 4 grains; and at 90°, 6 grains; so that at least six times as much moisture exists in the hottest days as in the coldest; we, however, feel the air to be drier, because at a temperature of 30° only 1 grain extra is required for perfect saturation, whilst at 90° it would require 8 or 10 grains extra.

If the air were completely saturated with moisture, the whole amount of water in a vertical column of the atmosphere would be 2¼ inches at a temperature of 30°, and 19½ inches at a temperature of 90°; but if the air were unusually dry, the amount would be 1¼ inches at 30°, and 10 inches at 90°. This little analysis of the atmosphere will give an insight into the subject; yet it does not afford us a clue to the reason why more ozone exists with the barometer low, unless we consider that, as wind accompanies a low state of the barometer, it is to be attributed to this cause alone.

From what has now been said, it becomes evident that certain corrections will become necessary before the actual amount of ozone can be determined.

We next come to the test used in these investigations, which was the subject of much discussion at the Cambridge meeting of the British Association. Great difficulty has always been experienced in producing tests that should all register alike; if we expose those of Schonbein and Moffatt's together, we do not get the same result, and even tests made by the same persons at two different times will also not read alike, and my investigations were with the view of finding out the cause of this. Commencing at the very beginning of their manufacture, it at once occurred to me that the starch of commerce of which they were made could not be sufficiently pure for such delicate experiments; in their manufacture, lime, sulphuric acid, and chlorine are used—substances which will themselves colour the tests without the aid of ozone. Place under a bell-glass a small cup of chloride of lime, and under another a piece of limestone, on which sulphuric acid has been poured, and under these glasses suspend an ozone test; a few minutes will suffice to demonstrate this. The ordinary iodide of potassium is impure; and

it is by no means easy to procure a proper chemically-pure paper; that which was used by Dr. Moffat (ordinary writing paper) is very impure.

Requiring pure starch, and uncertain what starch would be the best, I set about manufacturing it myself, without the usual aid of chemicals. The substances used were wheat, rice, sago, potato, arrowroot, crocus, snowdrop, tulip, narcissus, arum, etc.; these were reduced to powder, steeped in distilled water, which was constantly changed, until the pure starch alone remained, the result being perfectly satisfactory; a starch was produced from all the above substances, which, for whiteness and purity, could not be surpassed. Chemically-pure iodide of potassium was procured, through Mr. James Glaisher, from Mr. Squire, of Oxford Street, made expressly for these experiments; one portion prepared with water, and another crystallized several times from alcohol.

At the recommendation of Dr. R. D. Thomson, 15 grains of prepared chalk were added to every ounce of air-dried starch, to prevent sourness. This, unfortunately, has the effect of diminishing the sensitiveness of the tests, yet appears requisite for uniformity of effect, as the intensity of action depends much upon the amount of water contained in the starch. The following experiment will make this apparent:—A test made with air-dried starch showed the presence of ozone with 5 minutes' exposure. Further drying by fire-heat for one minute retarded it to 7 minutes; 10 minutes' drying by fire-heat retarded it to 13 minutes; 30 minutes' drying by fire-heat caused the presence of ozone not to be seen, with less than 20 minutes' exposure; whilst the same powders merely air-dried, yet having the addition of 15 grains of chalk to each ounce of starch, also occupied a 20 minutes' exposure before ozone could be detected.

With regard to the material used for tests, either *chemically-pure* calico or *chemically-pure* paper answered well; but ordinary writing-paper, or any other impure material, coloured in course of time. Some papers would be stained and useless in twelve hours.

We have said that the method of ascertaining the amount of ozone was by means of test-slips; but, in order to ascertain if something more sensitive might not be substituted, I tried as a first experiment a mixture of 10 parts of starch to 1 of iodide of potassium, carefully mixed together as a *dry powder test;* a small portion of this mixture was placed in a pill-box in the open air, and in the short space of ten minutes' exposure it was shown that *dry powder tests* were an undoubted success, colouring well, and much more rapidly than the test-slips.

The next determination was with regard to a proper formula—Schonbein using one of 10 parts starch to 1 of iodide of

potassium, and Moffat another of 2½ starch to 1 of iodide of potassium. No satisfactory reason was given why Moffat used so different a formula to Schonbein. It occurred to me that, if a number of different strengths were prepared from equal portions of each up to 30 parts of starch to 1 of iodide of potassium, that if one of these strengths was coloured sooner than another this should be the proper formula to adopt.

Having mixed a number of powders of different strengths with wheat starch, and exposed them to the air, a very short exposure showed that 1 part of iodide of potassium to 5 of starch was soonest coloured, and gradually darkened beyond all other strengths; and many repetitions of these experiments always gave the same results. The degree of darkness diminished in either direction when other strengths were used—thus, even 1 of iodide of potassium to 4½ of starch, or 1 to 5½, were neither so dark as with a strength of 1 to 5. It became, therefore, evident that these were the proper proportions to be used with wheat starch; or, at all events, with perfectly pure wheat starch, such as I had experimented upon. On repeating these experiments with potato starch, the proportion which coloured soonest was 1 to 2½ of starch, showing that the formula must be based on actual experiment, and that a special formula is requisite for each vegetable starch. It next became a question as to what starch would be most sensitive; and, to arrive at this, experiments were tried with tulips, crocus, narcissus, snowdrop, arum, etc.; and very fine starch was manufactured from the bulbs of all these plants. Investigations, which I am at the present moment engaged in, will soon show what starch will be the best to adopt.

Further experiments were tried, with the view of determining the effect of various acids, etc., on the ozone tests; and in order to ascertain this conclusively, two small cups were placed under a bell-glass—one containing an acid or other substance, and the other an ozone test powder. From these it was found that hydrochloric acid, nitric acid, nitrous acid, chloride of lime, phosphorus, iodine in scales, iodine dissolved in alcohol, carbonate of lime, and carbonate of iron, on which an acid had been poured, all coloured the tests, and some most rapidly. These experiments also showed that a new method of investigating ozone had become apparent; it was found that a different colour was imparted to the powder, and that the powder penetrated more or less deeply, according to what coloured the test; differences of effect took place, by which the different materials used might be recognized. IODINE, although it coloured to a *brown-black*, was merely a surface colouring, below which the powder was colourless; PHOSPHORUS, a *bluish-black*, on the surface only; CHLORIDE OF LIME, *deep brown*, on the surface only,

below which the powder was slightly yellow; HYDROCHLORIC ACID, *grey pink*, on the surface only, the powder beneath orange; NITRIC ACID, *dark red-brown*, extending slightly into the powder, beneath colourless; CARBONATE OF IRON WITH GLACIAL ACETIC ACID, *yellowish-brown*, penetrating to the thickness of cardboard, below which buff; LIMESTONE WITH SULPHURIC ACID, *pale-brown* to the thickness of cardboard, beneath which slightly coloured; CARBONATE OF IRON WITH SULPHURIC ACID, *black* to the depth of a quarter of an inch; NITROUS ACID, *dark brown* more than an eighth of an inch deep, beneath which yellowish-brown. These differences are so striking that important results must follow their investigation.

The action of ozone on the powders is somewhat analogous to that produced by nitric acid; yet dilute nitric acid, when increased to ten times the strength which the French philosophers declare is the proportion present in the air, is far too weak to produce any colour on the tests.

There are marked advantages in the *powder tests* over the ordinary test-slips; they are more sensitive and more rapidly acted upon, and they retain their maximum colour, not fading afterwards, as is the case with the test-slips of Schonbein and Moffat. For one of Mr. Glaisher's scientific balloon ascents I prepared some doubly-sensitive powder tests, which showed the presence of ozone in the short space of four minutes after leaving the earth, whilst the test-slips remained for nearly an hour uncoloured.

A careful consideration of several thousand experiments inclines me to the belief that ozone is always present in the air, as on no occasion has my sensitive dry powder test failed to show traces of it, even at a time when the ordinary test-slips have remained for days uncoloured.

Mr. Burder, of Clifton, near Bristol, has drawn attention to the fact that ozone is never present in a room even with the window open. Last autumn I carried on a series of experiments, from which the same fact was arrived at, so far as regards the ordinary test-slips, and this is because the air is more or less stagnant in doors; were these test-slips to be exposed out of doors whilst the air was calm or stagnant, they would not exhibit any signs of ozone. However, my delicate powder tests became faintly coloured not only with the window open, but in an apartment with a closed window. The current produced by a fire conveyed sufficient ozonized air across the test-powder to show the presence of a small quantity of ozone.

On the completion of a second series of experiments, we will return to the subject.

XUM

PORTABLE EQUATOREALS.

BY WILLIAM C. BURDER, F.R.A.S.

It is perhaps more important in regard to astronomical instruments than to most others, that there should be in the minds of those who use them distinct ideas of the objects in view in their construction, and their capabilities and limits as to usefulness.

Without such ideas, amateurs are very apt to make a false start, and to find themselves, consequently, obliged to return to their starting point, disappointed, both with their own work, and with the instruments which they have been attempting to use. Perhaps no instrument stands in need of this prefatory remark more than the Equatoreal, a name which probably conveys to the mind of the beginner an impression, in most cases, of a very different instrument from the one which his subsequent experience discovers it to be. To the professional astronomer who possesses a good steady working equatoreal, and who has no leisure for astronomical recreation, as such, it is easy to imagine that the term "portable," applied to equatoreals is by no means suggestive of pleasing associations. The very great difficulty experienced in constructing the larger sort of instruments, so as to combine great steadiness with a perfectly easy motion—qualities absolutely essential to their good performance—and the variety of causes which have a tendency to introduce sources of error in the working of the equatoreal, are reasons why the thoughts of the professional astronomer in reference to these instruments are likely to be very different from those of the amateur whose aim is astronomical amusement and instruction, rather than the advancement of the science, even in a feeble manner. The possessor of the portable equatoreal must consider himself happy if he finds his instrument a means of using an ordinary telescope to much greater advantage than would be possible without its aid. That he may do this there is not the slightest doubt. Indeed it is not too much to say that a simple equatoreal mounting for an ordinary pocket telescope multiplies its usefulness fourfold, or perhaps much more. We may take it for granted that the readers of the many interesting astronomical papers which have appeared in the Intellectual Observer, do not most of them require that many remarks should be made on the general principles of equatoreals; still, as there are always new readers to every article, the former class will, it is hoped, forgive the writer if he goes somewhat over old ground in a few preliminary remarks, in order to make the description more complete to the latter class.

The equatoreal, then, is a telescope mounted in such a manner as to enable the observer to follow the diurnal motion of a celestial object by one uniform movement round an axis. This axis produced would necessarily touch, so to speak, the heavens at the pole, the altitude of which equals the latitude of the place. Any method by which the observer can readily place this axis in such a position as to point to the pole in the heavens will place his instrument in adjustment and ready therefore for use; but in practice this is not so easy a matter as it might at first sight appear to be. In order that the telescope shall be correctly pointed to an object, the declination or north polar distance of the object must be known, and the index set to the proper division. The movement on the axis referred to will then be sufficient to ensure the telescope's following that object by the axial motion already referred to without again touching the motion for declination. A little consideration will show such matters very clearly. This diurnal axial motion is performed by a clock in the larger equatoreals, so that the declination circle being once set, the object remains in the field of view as long as it is above the horizon, without any further help from the observer. Of course this is on the assumption that the declination of the object in question does not itself change during the interval. The clockwork movement is a luxury which the possessor of the portable equatoreal must not hope to realize. He must be satisfied to move his instrument by hand, but when once he has carefully set the declination-circle he will find the following of the object by the one motion only, even by hand, a very great advantage compared with the "fishing" kind of use of the telescope which is necessary in other cases.

Several years ago the writer amused himself by trying to find out the simplest kind of construction capable of converting an ordinary pocket telescope into a portable equatoreal. The result is described in *Recreative Science*. The two movements used in the construction of that very useful little thing, a brass "clip," with an iron screw at its base to enable the observer to secure his telescope to a post, tree, window-sash, etc., with perfect steadiness, being the same in principle as those of the large equatoreals, suggested the using of such clip equatoreally. To do this it was necessary to graduate the two little circles where the motion is visible. There was some difficulty in this, but the labour was well bestowed, and the result was perfectly satisfactory. Thirteen years' occasional use of the instrument has quite proved this. It never fails in enabling the observer to find an object in the field of view by day or night. But it is in the daytime when the little instrument desires to display its powers most, when an object is found by it which could not

be found by the fishing process, and found at once by the setting of the circles, without touching the eye-piece end of the telescope.

Perhaps it may not be uninteresting to give an account of the performance of the writer's portable instrument on one particular occasion, when all circumstances combined to display it to the best advantage. The writer was desirous of proving the capabilities of the Portable Equatoreal in the presence of an astronomical authoress, well-known to the readers of the INTELLECTUAL OBSERVER—one whose works prove her to be peculiarly well qualified to appreciate any instrument calculated to illustrate the *recreative* character of the science. An opportunity occurring for showing the working of the instrument to several persons, among whom was the Hon. Mrs. Ward, one magnificent morning in July, 1859, the telescope and clip were placed in a small carpet bag, and a ticket was taken, *viâ* Midland Railway, to a delightful rural spot in Gloucestershire. The place being quite new to the writer, and the latitude and longitude differing from what had been adopted for the adjustment of the instrument at Clifton, so as entirely to throw out of the field of view any object sought without taking this difference into account—and there being no land mark previously determined for a south point, etc., made the occasion a good test of the capabilities of the instrument, and one which all present appreciated. The first step was to obtain a south mark. For this purpose, the sun, a watch, and the hour-circle of the clip placed horizontally, furnished the necessary materials. Making the requisite calculation for longitude, and taking an azimuth from the sun—previously calculated for several intervals from noon in case of need—I obtained a mark. A stick placed in the ground answered the purpose. The equatoreal was placed on a table on the lawn. One word by way of explanation of the azimuth, for the beginner. The time being known, the distance in degrees from the south, of a point in the horizon which is cut by a plumb-line held so as to bisect the sun, becomes known, and thus the south point is obtained by calculation. It is to be remembered that all this is for placing the instrument in a state of adjustment so that the axis may point to the pole as previously stated.

On the occasion referred to, the problem given was to find Venus in broad daylight, by means of the graduated little circles before mentioned. I now look at my watch, and having previously calculated how many degrees from her meridian passage Venus will be by the time that I have completed my adjustments, I set the telescope to the proper declination and distance from south corresponding to such interval from her meridian passage, and predict that at such and such a minute she

will be in the field of view. On this occasion I might have been forgiven if a blunder had taken place, as it is much more difficult to avoid such awkward result when any effort is made to sustain a conversation and calculate at the same time; but luck favoured me, and having set the instrument, I had the pleasure of requesting that the authoress to whom I have referred should look through the telescope at once before I had done so, so as to make the performance of the equatoreal the more satisfactory. And there was the planet sure enough, and, as luck would have it, very near the centre of the field. I say luck as to this, because the instrument does not profess to do so much, although I may say that if care be taken in the adjustments, the object is always nearer to the centre than to the edges of the field. I can assure the reader that on this fine summer's day so successful an exhibition of the instrument under such agreeable circumstances was a real treat to me; and I have no doubt that any enthusiastic amateur who may happen to read this account will be able to imagine the satisfaction I felt. As a still more severe test of the instrument, but one which I did not quite like to risk *first*, I afterwards found Arcturus in the same manner. As the power used was only 20, and the diameter of the object-glass $1\frac{1}{4}$ inch only, there was a risk of not seeing *stars*, which, of course, even first magnitudes, are extremely faint in broad daylight. But if Venus be not found, it may always be taken for granted that she is not in the field of view, unless, indeed she is very near the sun, or the sky is at all hazy. Under a clear atmosphere Jupiter can easily be seen also in broad daylight, and Saturn when the daylight has only very slightly declined.

I have probably said enough to show that the portable equatoreal is an instrument of a most recreative kind. But it is more. It is really very *useful*. By means of it, for iinstance, a comet whose R A. and N. P. D. are known may be found very much earlier than with an ordinary telescope. The instrument being set to a certain position, a comet may be seen in strong twilight, when the chances would be greatly against finding it by an instrument not graduated. At first view, it may strike some readers as a very rough kind of thing not to have circles graduated so as to be certain to a quarter of a degree; but two considerations will enable the reader to view this in a very different light. The first is, that the circles graduated are less than one inch in diameter and divided by hand (of course this would be better done by machine); and the second is, that the resultant error may be the *accumulation* of several errors in adjusting the instrument, all which adjustments are necessarily rough. I will here remark, in answer

to objections on the ground of the smallness of the circles, that any increase in the diameter of these circles destroys to that extent the compactness and portability of the "clip"; in fact, the great end in view, that of making the portable little piece of mechanism which goes by that name, answer many really useful purposes, besides those originally contemplated in its construction—at the same time without interfering with its own original capabilities—would not be attained if the diameter of the circles were materially increased.

I will finish my description by noticing another advantage of the instrument—that of an unattached *day-finder* for a larger instrument. When once the object, such as Venus or Jupiter, is in the field of the small equatoreal, a large instrument may be directed to such object with great ease. My plan is as follows:—Make the outside edges of the two telescopes sensibly parallel, by eye, and, by means of an instrument consisting of a level and graduated arc, make the inclination of both to the horizon the same. After a few seconds employed in doing this, the object will be found in the larger instrument. Some years ago I found this plan most convenient in directing a large reflector, 12 inches diameter, to Venus, Jupiter, and Saturn, when it would have been hopeless to attempt to find them by ordinary means.*

ON THE ANCIENT LAKE HABITATIONS OF SWITZERLAND.

BY HENRY WOODWARD, F.Z.S.

(*With a Tinted Plate.*)

THE evidence of the high antiquity of man has long occupied the earnest attention of scientific men, and has of late attracted the notice of educated people generally.

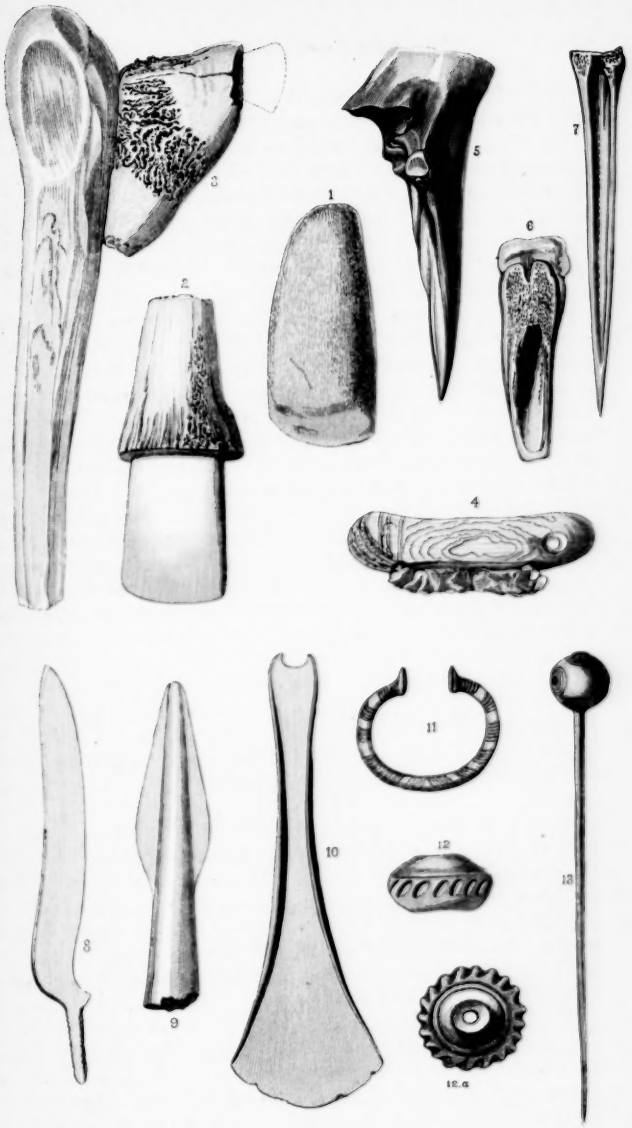
The reason for this will be found in the number and importance of the discoveries made of late years in localities as widely separated as Ireland and Switzerland, France and Denmark, England and Belgium.

These discoveries include:—

I. Oval and spear-shaped flint implements of a rude but uniform type, occurring in "drift-gravels" in the valleys of the Seine and Somme, in France; the Ouse and the Waveney, in England, etc., etc., associated with the remains of extinct species of elephants and other pachyderms, etc.

II. Human remains and implements, with horns, bones, and

* Horne and Thornthwaite's "Star Finder" is an elegant instrument for this purpose.—ED.



IMPLEMENTS AND ORNAMENTS

of the Bronze and Stone Periods, from the Swiss Lake Dwellings.
One-third nat. size. Drawn from Specimens in the British Museum.
(except No. 4, which is after M. Troyon's figure.)

teeth of extinct animals, in caverns near Torquay, Devonshire; Liégé, Belgium; and many localities in France and Germany.

III. Shell-mounds, or "kitchen-refuse heaps" (Kjokken-mödding), containing flint implements and other reliques, and bones of various animals, birds, and fish, found almost everywhere along the Danish coast.

IV. Works of art, of three distinct epochs, in the Danish peat-mosses.

V. Artificial islands (*Crannoges*), with abundance of animal remains, and works of art from the Irish lakes and peat bogs.

VI. "Pile-works" (*Pfahlbauten*) of the Swiss lakes.

The last-mentioned of these discoveries is so interesting, that I purpose to give a brief *résumé* of the facts and results for the information of those who may not have read the various details, published elsewhere.*

The objects figured in the engraving† are (with one exception) exhibited in the British room of the British Museum, and are selected from the small but choice collection obtained in part through the kind exertions of the Honourable Admiral Harris, H.B.M. Minister at Berne, and in part presented by Colonel Schwab, of Bienne.

I shall refer to them in the course of my narrative, and give a list of objects at the end. The collection represents no fewer than twelve localities, and seven different lakes.

The Swiss fishermen and boatmen had frequently observed, during calm weather, what appeared to them to be the clustering collections of erect stems of trees, from ten to twenty feet beneath the surface, in the clear waters of the lakes, which were supposed to be remains of submerged forests. They

* The writer begs to express his thanks to his friend, Mr. John Evans, F.S.A., F.G.S., etc., and to his colleague, Mr. A. W. Franks, F.S.A., etc., of the Department of Antiquities, who have kindly assisted him with valuable information suggestions, and advice. Those who desire a more full account are referred to the following works, to which the writer begs to acknowledge himself indebted for much information and most of his facts:—

"The Ulster Journal of Archæology," 1859, Belfast, vol. vii., No. 27, pp. 179—194. [A translation of a paper by M. Fred. Troyon, on Swiss Lake Dwellings, and an Account of Irish Crannoges.] "Archæologia," London, 1860, vol. xxxviii., p. 177: W. M. Wylie, M.A., on Lake Dwellings of the Early Periods. "Natural History Review," 1862, vol. ii.: J. Lubbock on the Ancient Swiss Lake Dwellings, etc. Lyell, "Antiquity of Man," London, Nov. 1863. Troyon, Fred., "Habitations Lacustres," Lausanne, 1860, 8vo. Keller, Dr. Fred. "Die Pfahlbauten," in Mittheilungen Der Antiq. Gesellschaft, Zurich, Bd. xii., 1858, and B. xiii., 1860. Rütimeyer, Dr. L. "Untersuchung der Thierreste aus den Pfahlbauten der Schweiz," in ditto, Bd. xiii., 1860. Keller, Dr. F., "Keltischen Pfahlbauten in den Schweizerseen," Zurich, 1854. Herodotus, lib. v., cap. 16. "Illustrated Catalogue of the Museum of Royal Irish Academy, Dublin," by Mr. W. R. Wilde, M.R.I.A., on "Crannoges." M. Morlot, "Leçon d'Ouverture d'un cours sur la haute Antiquité fait a l'Académie de Lausanne."

† The original drawing was most carefully prepared from the specimens, by my friend, Mr. J. Dinkel, of Oakley Square.

were noticed to run in a parallel direction with the shore, and about 100 yards distant from it; but no investigation of their true nature was made until 1853.

In consequence of the dryness of the winter of 1853-4, the Swiss lakes and rivers sank lower than had ever been previously known; and the inhabitants of Meilen, on the Lake of Zurich, availed themselves of the opportunity to recover a piece of ground from the lake, by raising its level with mud taken from the neighbouring shallows. Whilst excavating, they discovered a number of wooden piles, deeply driven into the bed of the lake, formed of the stems of oaks, beech, birch, and fir trees. The mud among these piles contained a great mass of reliques, consisting of numerous bones of animals, all of which had been cut, broken, or gnawed, and the marrow extracted; hammers, corn-crushers, a great variety of axes and celts, of various kinds of stone, many of which were fitted into hafts of stag's-horn. Flint implements were also numerous, which is the more remarkable, as flint is rarely found in that country. Large slabs of stone, which had been used as hearth-stones, were also noticed. One amber bead was found, which, it is supposed, must have been brought from the shores of the Baltic. One or two hatchets and wedges of jade have also been met with, the material for which, it has been asserted, could only have been obtained from the East. But it seems much more probable that both these substances were occasionally, although very rarely, found in Switzerland or the south of France, rather than (as has been proposed by some archæologists) to suggest that this ancient race trafficked with northern and eastern tribes to obtain axes of jade or ornaments of amber. Pottery occurred in abundance, but always in a very fragmentary state. It was hand-made, and of a rude and coarse description. Masses of charred wood, apparently parts of the platform of the building, were abundant. Indeed, it was evident that not only this settlement, but the great majority of those subsequently found, perished by fire. Since the first discovery of pile-works at Meilen, the Swiss archæologists have displayed untiring industry in exploring fresh localities, and not only in lakes Constance, Geneva, Neuchâtel, Bienne,* Zurich, Morat, Sempach, but also in the smaller lakes of Inkwijl, Pfeffikon, Moosseedorf, and Luissel, similar lake-dwellings have been discovered.

The earliest pile-works, those belonging to the Stone age, present a very rude appearance, the stakes having been sharpened by stone hatchets, assisted by fire. Fire was, no doubt,

* Eleven settlements have been found on the Lake of Bienne, twenty-six on the Lakeof Neuchâtel, twenty-four on the Lake of Geneva, and sixteen on the Lake of Constance.

also used to assist in cutting down the trees in the first instance, and the timber has all been split by means of wedges.

After the necessary rows of piles had been driven, these were strengthened by cross-beams, which supported the wooden platform upon which the huts were constructed. These cabins were mostly circular in form. A singular evidence of this is derived from the discovery of curved pieces of clay, with which the interior had been plastered.

Their preservation is due to the hardening action of the fires within the hut, and also to the ultimate destruction of the settlement by a conflagration. These pieces of burnt clay also bear the impression of interlaced twigs upon their outer surface, thus indicating that the walls were constructed of "wattle" lined with clay.

Portions, apparently, of the thatched roofs are also not uncommon. In Prof. Keller's restorations both round and square huts are represented, similar forms of cabins being in use among the papoos of New Guinea at the present day.*

Some of these pile-works were of very considerable extent. For example, the settlement at Morges, on the Lake of Geneva, was 1200 feet long and 150 broad, thus giving a surface of 180,000 square feet. At Wangen alone, on the Lake of Constance, M. Lohle has estimated that 40,000 piles were employed, probably representing the labours of several generations. M. Troyon and others have made several calculations, with a view to ascertain the probable population of these villages. Thus estimating the cabins at fifteen feet in diameter,† and allowing half the area of the platform for gangways between the dwellings, it would give for Morges 311 cabins, which, at four persons for each cabin, would give a population for the settlement of 1244: whilst for the settlements upon the Lake of Neuchâtel it would give a population of about 5000.

These lake dwellings are most admirably separated chronologically by the remains of works of art included in the mud around the pile-works.

The earliest undoubtedly belong to the Stone age (as it has been named), when metals of any kind were wholly unknown, all the weapons found being made either of stone or of the bones and horns of animals. To this epoch belong Wauwyl and Robenhausen, on Lake Pfeffikon, Wangen, on Lake Constance, and the settlement of Moosseedorf.

* Dumont d'Urville, "Voyage de l'Astrolabe." Paris, 1833. Tome IV., p. 607.

† Here again the pieces of burnt clay have done good service, for the smallest segment, if only sufficient to indicate the curve, will give the size of the circle with certainty.

The next series represent the age of Bronze. Here ornaments and weapons, often of high artistic merit, are found, and the other remains indicate the knowledge of useful arts, as spinning, and the manufacture of a higher class of probably wheel-turned pottery. This era is represented by the settlements of Meilen, Bienne, Concise,* and many others. Lastly, at Auvernier, in the Lake of Neuchâtel, and at the Steinberg, in the Lake of Bienne, a few weapons of iron have even been met with.

The distance from the shore at which the piles were driven appears to have been regulated by the nature of the bottom of the lake and the depth of the water. Some few could evidently have been reached only by a boat; but most of them appear to have been connected with the land by means of a narrow gangway supported on piles, a portion at least of which could be readily removed, so as to insure security from the attacks of bears or wolves during the night, or as a means of defending themselves against the hostile raids of neighbouring and more powerful races.

Many canoes have been discovered, associated with the Swiss pile-works, each made of a single tree, and measuring forty to fifty feet in length, and three to four feet in width, the interior hollowed out by stone hatchets, aided by fires. Similar canoes are still used, both upon the rivers of Western Africa and North and South America; and one of my German friends tells me he has frequently crossed both lakes and rivers in Bavaria in such a boat, called an *einbäum*. Early British and Irish canoes were likewise of the same pattern, according to Professor Wm. King, and were used in the latter country so lately as two centuries ago.

Herodotus (lib. v., cap. 16) gives an account of a race called Paeonians, inhabiting pile-dwellings (B.C. 520) in Lake Prasias, in Thrace (now part of modern Roumelia).

Each cabin had a trap-door opening on to the lake, in which fish was so abundant, that it was only necessary to lower a basket by a cord into the water, and haul it up again, and it was found to be filled with fish. When their country was invaded by the Persians, they retired to their impregnable lake habitations with their horses and cattle, subsisting upon fish, and so defied the invader. That horses would eat fish at all, might at first seem incredible; but my late colleague, Mr. Adam White (of the Zoological Department), has recorded, in his *Natural History of Animals* (p. 28), that "both cows and ponies in Shetland readily eat fish-heads in winter!" so that Herodotus was probably correct in his statement.

They made the first platform at the public expense; but

* Meilen, on Lake Zurich, and Concise, on the Lake of Neuchâtel, appear to have been inhabited in both the Stone and Bronze periods.

subsequently, at every marriage (and polygamy was customary), the bridegroom was required to add three piles to the structure.

These habitations, reared upon the bosom of the lake with so much patient industry, unaided by any of those modern inventions which make labour light, were not only intended for places of safe retreat during hostile times, but were also used by each community as their constant place of abode, and all the relics exhumed tell of regular every-day life and permanent occupation.

From the position of these lacustrine dwellings, we should have predicted that they were inhabited by a race of fishermen. The account given by Herodotus of the Paeonians, and the discovery of fish-hooks and pieces of nets, and abundance of fish bones beneath the pile-works, fully confirms this opinion. But the ancient Helvetii were by no means dependent upon the waters alone for their daily food; they hunted and shot the smaller game with bows and arrows, and probably took the larger in pitfalls, as the Zulu Kaffirs do at the present day. In these pursuits they were, from the earliest times, accompanied by man's first and most faithful friend, the dog.

The bones of no fewer than thirty-two animals (most of which were used as food) have been discovered in the various pile-works of the Swiss lakes, and determined by Prof. Rütimeyer.* That able zoologist has also recorded the occurrence of the bones of eighteen species of birds, eight fishes, and two reptiles (these last are the edible frog and the freshwater tortoise; the latter now quite extinct in Switzerland). But, as I have already stated, the earliest of these Swiss settlements indicates a later Stone period than that of the valley of the Somme. No trace of the elephant, rhinoceros, hippopotamus, hyæna, cave bear, or lion (all of which appear to have co-existed with the makers of the flint implements of the earliest Stone period) have been found here; but the urus and bison, the elk and the red-deer, were no mean cattle; and for carnivora, they had to contend with the brown bear, the wolf, the fox, and half-a-dozen smaller denizens of the forest; whilst the fierce wild boar, and the scarcely less formidable marsh boar, also abounded in the woods and lowlands. These animals not only supplied them with food, but their bones and teeth were afterwards converted into weapons and ornaments of various kinds; the horns of the deer serving as hafts for stone implements, and the bones for pins, augers, chisels, and gouges (see plate and description); whilst their skins were doubtless used as articles of dress, etc. Nor was agriculture entirely unknown. Of this we find most conclusive evidence in the carbonized remains of wheat and

* Of these, eight appear to have been domesticated, viz., the dog, pig, horse, ass, goat, sheep, and two species of oxen.

barley, several bushels of the former cereal having been found at Wangen, the grains adhering together in large masses. Ears of barley are also numerous.

Carbonized cakes of unleavened bread, and the round stones used in grinding the corn, have also been found here, and may be seen in the collection. No agricultural implements, except sickles of bronze, have yet been discovered; their other instruments of tillage were doubtless made of wood.

The uncultivated fruit-trees of the forest supplied them abundantly with apples and pears, wild plums, prunes, hazel-nuts, and beech-nuts, great abundance of the stones and shells of which, and also seeds of the raspberry and blackberry, are found in the mud around their dwellings. The apples are often found cut in two, and apparently dried for winter use, as is the custom in America at the present day.

Seeds of the water caltrop (*Trapa natans*), now almost extinct in Switzerland, are met with, and are believed to have been used as articles of food. The fibres of flax and hemp have also been found applied to useful purposes, such as cords, netting, and woven fabrics for clothing. (See list of specimens in collection.)

Professor Rütimeyer's examination of the remains of animals obtained from the various settlements, has led to the most interesting conclusions respecting the modes of life of their occupants. For example, in the oldest settlements, those of the Stone age, such as Wanwyl and Moosseedorf, the remains of the stag predominate over the ox, and the goat over the sheep, the wild boar over the domestic hog, the fox over the dog; whilst at Bienne and Meilen, settlements of the Bronze age, the dog predominates over the fox, the domestic hog over the wild boar, the sheep over the goats. Lastly, at the Steinberg (which I have already mentioned as a settlement that lasted down to the introduction of iron), we find numerous bones of the horse, an animal whose remains are *extremely rare* in the earlier settlements. Thus, the Stone age may be said to represent the epoch of the hunter; the Bronze, the pastoral age; whilst the commencement of the Iron age probably witnessed the demolition of the latest pile-works, and was to the Swiss lake-dwellers a time of invasion, conquest, and ultimate destruction by a foreign and more powerful race.

Of their religious superstitions we know little. That they eat foxes and eschewed the hare seems proved by the frequent occurrence of foxes' bones, and the discovery of but one solitary bone of the hare up to the present time.* Col. Schwab

* Such a superstition still prevails among the Laplanders at the present day. The Russians even refuse to eat it! This aversion to the hare is also noticed by Julius Cæsar, in his *Commentaries* (lib. v., cap. xii.), as existing among the ancient Britons.

has discovered a great number of crescents made of earthenware (measuring about one foot across, from horn to horn), compressed at the sides, and sometimes ornamented.

They were probably affixed to the summit of their circular huts. Dr. Keller considers them religious emblems, and to be evidence of moon-worship. The remains of the mistletoe have also been found. This parasitic plant has always been associated with religious rites from the earliest times.

Notwithstanding the profusion of bones of animals in the Swiss pile-works, the occurrence of human remains is extremely rare, which would seem to indicate, that although the conflagrations by which the settlements had been destroyed at various periods had been sudden and overwhelming, yet the inhabitants had always managed to escape with their lives, in boats or otherwise.

Only one skull of the early Stone period, dredged up from Meilen, on the Lake of Zurich, has yet been examined with care. Of this, Prof. His observes, that it clearly resembles in form the skull of the race at present prevailing in Switzerland, which is intermediate between the long-headed and short-headed form.

The duration of time occupied by the epochs just described must naturally be very great, to allow changes so important as those we have indicated gradually to take place. In Denmark each period is marked by a *complete change* in the forest trees of the country. The Scotch fir, the oak, and the beech-tree, have each covered the land, and each in turn has died out, and been replaced by its successor—a process requiring *many tens of centuries* to effect.

The Swiss archæologists and geologists have endeavoured, by a very careful series of calculations, to estimate definitely the periods of time and relative antiquity of the Stone and Bronze ages. The calculations of M. Morlot are based upon an examination of the delta formed by a torrent, known as the Tinière, which falls into the Lake of Geneva, near Villeneuve. This delta was laid open by a railway cutting 1000 feet long and 32 feet deep, and its structure throughout displayed such regularity, as to imply that it had been formed very gradually, and by the uniform action of the same causes.

Three layers of vegetable soil have been exposed, each of which must at one time have formed the surface of this cone-shaped deposit. They are regularly inter-laminated among the gravel, and exactly parallel to one another, as well as to the present curved surface of the cone. The first of these ancient deposits was traced over a surface of 15,000 square feet, at a depth of about four feet. This layer, which was from four to six inches in thickness, belonged to the Roman period, and

contained Roman tiles, and also a coin. The second layer was followed over an area of 25,000 square feet, at a depth of ten feet from the surface, and had a thickness of six inches. It is referred to the Bronze epoch, for in it was found several fragments of unvarnished pottery, and a pair of bronze tweezers. The third layer was traced for 35,000 square feet, at a depth of nineteen feet, and was six to seven inches in thickness. In it were found a human skeleton, with a small, round, and very thick skull, some fragments of very rude pottery, some pieces of charcoal, and some broken bones.

M. Morlot, assuming the Roman period (indicated by the first layer) to represent an antiquity of from sixteen to eighteen centuries, assigns to the second layer, representing the Bronze age, an antiquity of 3800 years, and 6400 years for the third layer of the Stone age.

The second case is afforded by a settlement found buried in peat at the foot of Mount Chamblon, 5500 feet from the present margin of the Lake of Neuchâtel. The Roman City of Eburodunum (Yverdon) was built on a *dune* extending from Jorat to the Thièle. Between this *dune* and the lake, on the site at present occupied by the city of Yverdon, no trace of Roman antiquities has ever been discovered, from which it is argued that the waters of the lake washed the walls of the ancient Castrum Eburodense.

If then 2500 feet have been uncovered in 1500 years, M. Troyon infers that 3300 years must have elapsed since the pile-dwellings at Chamblon were left dry. As this settlement belonged to the Bronze period, the date arrived at agrees very well with that obtained from the delta of the Tinière.

I have only described the construction of the most usual form of Swiss pile work; that in which the platform is fixed to the tops of the piles at a sufficient elevation above the lake to secure the habitations against a sudden rising of the waters. But at Wauwyl, in Lucerne,* the platform consisted of FIVE LAYERS of round timbers securely united together with interlaced branches of trees and the interstices filled with clay. *No fastening of any kind* could be discovered to connect the piles with this massive platform, and it would seem, from a close and careful examination, that the rows of piles only served to retain it in its place, the platform itself floating upon the surface of the water and rising and falling with it.

Again, at the Steinberg, in the Lake of Bienne, an artificial island has been formed by collecting a mass of round

* See Dr. Keller's Memoir, Zurich, 1860 (p. 73), already quoted, for M. Suter's description of this remarkable settlement of the Stone period.

stones,* which are kept together by means of planks of wood, and a circle of piles driven vertically around the mound which is now considerably beneath the present surface of the lake, owing to a supposed rise in the level of the waters. And, lastly, a small island in the little Inkwyl Lake exactly reproduces the *crannoge* which I have mentioned already as so frequently occurring in the lakes of Ireland. Of these *crannoges*, which are sufficient of themselves to form the subject of a separate paper, I will only remark that no fewer than forty-six have been discovered and described, from which remains of the Stone, Bronze, and Iron Age have been obtained. They are frequently referred to in the early annals of the country so far back as the ninth century, and have been used as strongholds and refuges by petty chiefs, rebels, marauders, and freebooters, down to the close of the seventeenth century. They are extremely rich in reliques, but little has yet been done in *systematically* examining and separating their very miscellaneous contents.

I have been informed that the Royal Irish Academy is about to take active measures to harvest this rich field of archæological treasures.

Lake-dwellings have been noticed as having existed in several parts of Asia. In a series of bas-reliefs found at Kouyunjik in the palace of Sennacherib, are represented the conquests of the Assyrians over a tribe who inhabited a marshy region; in one of these slabs† we see represented several small artificial islands (formed apparently by wattling together the branches and twigs of the willows which grew in the marshes, and erecting a platform), in which are sheltered five or six people. Mr. Layard has conjectured that these slabs represent the conquests of the Assyrians over the inhabitants of the lower part of the Euphrates.‡

That lake-dwellings will yet be discovered in England is highly probable. The fens of Cambridge and Lincolnshire and the meres and broads of Norfolk seem ready to reward the explorer. I will give a single instance in point. In draining a mere near Wretham Hall, Thetford, Norfolk, numerous posts of oak-wood, shaped and pointed by human art, were found standing erect, entirely buried in the peat. At a depth of from five to six feet from the surface were found some *very large* antlers of the red deer, several of which, with the skulls attached, had been *sawn off*, just above the brow-antlers.§

* A canoe, laden with stones, was actually found near this spot, having apparently capsized and sunk during the period when the Steinberg was in course of construction. It is one of the largest known, and measures fifty feet in length and three and a half feet in width.

† Engraved in the *Monuments of Nineveh*, second series, pl. 25.

‡ See *Nineveh and Babylon*, 1853, p. 584.

§ See *Quarterly Journal of the Geological Society*, London, 1856, vol. xii. p. 356.

Let me, in conclusion, caution the readers of this journal against the grave error of supposing that, because an era of civilization is well-marked and wide-spread, that, therefore it was contemporaneous throughout the area in which it is known to have prevailed. In proof of this I need only remark that *pile-works* are in fashion now-a-days among the Papoos; that the *einbäum* still floats on many a lake and river; and that, notwithstanding all the efforts of Birmingham and Sheffield, the Fuegian and Andaman Islanders have to-day eaten their dinner with the aid of stone cutlery. So true is it, that "man, placed under analogous circumstances, acts in an analogous manner, irrespective of time and locality."*

Explanation of Plate.—Fig. 1. Stone axe of Serpentine; Concise, Lake of Neuchâtel. 2. Stone axe, fitted into haft of stag's horn; Robenhausen, Lake of Pfeffikon. 3. Haft of stag's horn, with projecting wing, which rests against the handle of wood, in which a square hole has been cut to receive the shaft. [The handle itself is a fac-simile of one found at Concise, Neuchâtel.] 4. Flint saw, formed of a flake of flint fixed into a groove in a wooden handle with a cement of black mastic. [Copied from M. Troyon's *Habitations Lacustres*, Pl. v. f. 11.†] 5. Awl of bone, formed of the *Ulna* of *Cervus Elaphus*; Moosseedorf. 6. Gouge, or chisel, formed of metacarpal bone of deer; Wangen, Constance. 7. Long slender pin, made of metatarsal bone of deer; Moosseedorf. 8. Bronze knife blade; Cortaillod, Lake of Neuchâtel. 9. Spear head of bronze; Nidau Steinberg, Lake of Bienne. 10. Long slender bronze celt; Mielen, Lake of Zurich. 11. Ornamented armlet of bronze; Cortaillod, Lake of Neuchâtel. 12 and 12a. terra-cotta whorl, used in spinning with the distaff; Cortaillod, Lake of Neuchâtel. 13. Bronze pin, ornamented with circles; (probably worn in the hair); Cortaillod, Lake of Neuchâtel.

List of Specimens from the Swiss lake dwellings in the British Antiquities' Room, British Museum:—

Abbreviations.—Moosseedorf (M.), Robenhausen (R.), Wangen (W.), Concise (C.)

VEGETABLE SUBSTANCES.

Seeds of Flax *Linum usitatissimum*, R.
„ Raspberry, *Rubus idæus*, W. & M.
„ Blackberry, *R. fruticosus*, W. & M.
„ Water caltrop, *Trapa natans*, M.
Wheat (clean), *Triticum sativum* W. & M.
Six-rowed Barley, in ear, *Hordeum hexastichon* . . . . . W.
Two-rowed Barley, in ear, *Hordeum disticum* . . . . . W.
Hazel Nuts, *Corylus avellana* . . M.
Beech Nuts, *Fagus sylvatica* . . M.
Seeds, etc., of Apple, *Pyrus malus*, M.
Apples split and dried for winter use . . . . . W.
Leaves, etc., of the Mistletoe, *Viscum album* . . . . . M.

* F. Troyon, *lib. cit.*

† M. Troyon remarks that such flint saws are used by the Oceanic races in the manufacture of stone implements at the present day.

Specimens of Woods used in the pile-works, White Birch, *Betula alba*, M.
Pine, *Pinus*, sp.

FABRICS.

Fragment of Fishing Net made of Hemp? meshes 2 inches square . R.
Fragment of Coarse Fringe of a Dress, R.
„ Coarse Woven Fabric . . . R.
„ Fabric plaited by Hand . . R.
„ Cord made of Willow Bark . M.
„ Burnt Bread, or Cake . . . W.
Piece of Yew Tree, with cuts of a stone axe . . . . . M.
Burnt Wood . . . . . M.
Portion of the stem of the Flax in the first process of manufacture . R.

FRAGMENTS OF BONES OF THE

Fox, *Canis vulpes* (*ulna*) . . . . M.
Beaver, *Castor fiber* (1 *incisor*, 1 left *femur*) . . . . . M.
Wild Boar, *Sus scrofa ferus* (1 right *tibia*) . . . . . M.
Marsh Boar, *Sus scrofa palustris* (1 *ulna*, 1 *molar*, 1 *jaw*) . . . . M.
Stag. *Cervus Elaphus* (1 right *femur*, 1 left *humerus*) . . . . . M.
Roebuck, *Cervus capreolus* (Horn) M.
Goat, *Capra*, sp.? (*tibia*, *Jaw*) . . M.
Urus, *Bos primigenius* . . . . M.
Ox? *Bos taurus* . . . . . M.
Fragments of various Bones gnawed by dogs?
Prong of a Deer's Horn gnawed by rats.
Various Bones and pieces of Horn cut and marked by flint implements.

BONES, ETC., MADE INTO IMPLEMENTS.

4 Hafts of Stag's Horn, hollowed to receive stone axes . . . . . C.
7 Awls and Pins, made of various bones . . . . . M.
17 Chisels and Knives . . . . M.
4 Chisels or Gouges . . . . . W.
1 Haft, with entire Celt *in situ* . R.
1 Haft, with broken Celt *in situ*, St. Aubin.
1 Haft of Stag's Horn . . St. Aubin.
4 Pointed Bone Instruments . . W.
1 Small Needle? . . . . . M.

IMPLEMENTS OF STONE, ETC.

10 Stone Celts, or Axe-heads, made of Serpentine . . . . . W.
Cast of Axe-head made of Jade? (*original from*) M.
2 Flint Arrow heads . . . W. & M.
5 Flint Saws and Knives . . . M
6 Flint Scrapers . . . . . M.
Stone Hammer . . . . . W.
2 Round Stone Corn Crushers . . W.
Stone Axe in course of manufacture, with traces of flint saw-marks . W.
Sandstone used in grinding Celts . M.
2 Celts of Serpentine . . . C. & R.
42 Flint Flakes of various forms . M.
18 Flint Knives . . . . . M.
8 Flint Chips . . . . . M.

ARTICLES OF POTTERY, ETC.

13 Fragments of Coarse Pottery, hand-made . . . . . M.
4 Portions of Earthen Pots, used to store corn in . . . . . W.
1 Piece of a Vase ornamented with a tree pattern . . . . . W.
7 Pieces of rough Pottery . Inkwijl.
2 Earthen Cups (one of which is very elegant in form) . Cortaillod, Lake of Neuchâtel.
Fragment of a Large Vase, Auvernier, Lake of Neuchâtel.
6 Terra-cotta whorls, used in spinning with the distaff . . . Cortaillod.
Portions of the Clay coating the interior of the huts, indurated by fire . W.

WORKS OF ART IN BRONZE.

3 Knife Blades . Cortaillod, Lake of Neuchâtel.
1 Hair Pin Do. do.
2 Celts, with loops Do. do.
9 Rings Do. do.
3 Armlets Do. do.
1 Razor, or Leather Cutter Do. do.
6 Ornamented Pins . . . . Bevais.
1 Long slender Celt, Meilen, L. of Zurich.
1 Chisel . Nidau Steinberg, L. Bienne.

VORACITY OF THE ASPLANCHNA, AND ITS STOMACH CURRENTS.

BY HENRY J. SLACK, F.G.S.,

Member of the Microscopical Society of London.

THE ordinary text-books do not contain a satisfactory portrait of one of the most interesting rotifers, the *Asplanchna Brightwellii*, and the peculiar arrangement and mobility of the various parts render it almost impossible that a striking likeness should be produced.* In two successive seasons I obtained these creatures from Hampstead Heath, and last November and December found them fairly plentiful in one or two very small ponds at the back of the Castle Tavern. When a fortunate dip is made, and the bottle held up to the light, little exquisitely transparent glassy bags will be seen swimming about, and they will be made noticeable, less by their extremely delicate outline than by a solid-looking patch of coloured matter, generally golden yellow, which stimulates curiosity to find out what they are. As I wish, when opportunity offers, to resume the investigation of these remarkable rotifers, I shall not now append any drawings, or discuss minute details of their organization. Their name designates an astounding peculiarity—the absence of a bowel or anus, which might have been thought indispensable to a creature so highly organized as the asplanchna undoubtedly is.

The *Asplanchna Brightwellii* is almost a twenty-fourth of an inch long. The jaws are called "one-toothed," but the appellation is scarcely correct, as these organs consist of two arms, cleft at their extremities, and having a large toothed projection rather less than half-way down. A carefully-made drawing is before me as I write, and the general impression, when the curved arms (rami and mallei) are placed upright, is not unlike that of a pair of antlers, and they do not seem much better fitted for anything like *chewing* the food that passes through them. Whatever is swallowed goes down a conspicuous gullet, and a very extensible crop, often seen in folds, and abounding in delicate muscular bands. My hope was to find that this was in some way divided, and that there existed a distinct exit-pipe. In this I was unable to succeed, and I can offer no explanation of the riddle which the asplanchna presents. The crop terminates in a stomach of rounded, but irregular form, and when the creature is quiet, the long ovary is folded in a horseshoe round the digestive bag. This ovary

* Since writing the above, Mr. Gosse has allowed me to see his collection of drawings of these creatures, and, as might be expected, they are far superior to any others. The asplanchna requires to be studied in a series of sketches.

may be roughly compared to a long omnibus cushion with rounded ends. It is capable of much motion, and some apparent change of form. I have just mentioned what I may call its normal position; but in a sketch before me, the stomach has ascended quite above it, and below it lies a large, rough, resting egg, nearly ready for expulsion.* Situated a little above the orifice from which the eggs or young are discharged, is the contractile vesicle, or heart, whose motions are easily seen when the other life apparatus is out of the way. There are also complicated tubes, which under favourable circumstances exhibit the so-called "tremulous bodies"—little finger-like projections, on which a high power detects ciliary action that has been supposed to be connected with the animal's respiration.

It is a most voracious creature, and its stomach is often a natural history museum. The teeth do not damage the objects as they go down, so that in one of my specimens I found a small volvox apparently uninjured, and waiting the slow operation of the digestive juice. Mr. Gosse also mentions an instance in which a rotifer that had been passed into the stomach escaped alive. In the stomach of another asplanchna, of which a drawing was made, were no less than seven small rotifers and the jaw of an eighth, one arcella, and a quantity of imperfectly crystallized transparent particles, that acted upon polarized light, and may have been uric acid, together with a mass of matter too much digested to determine its origin. The asplanchna is not only willing to swallow any number of her fellow-creatures, animal or vegetable, that her stomach can possibly hold, but she gulps down objects apparently as inconvenient as if a man should swallow a rolling pin, or the kitchen poker itself. When such an awkward article has been bolted, the stomach is widely distended; the crop does its part to make room for the visitor, by pursuing the same course, and the result is that the entire digestive passage, and stomach bag, together take a triangular form. I saw several instances of this curious process. In one a—relatively—very large piece of the tracheal tube of some insect was stretched like a beam across the stomach, which it pushed quite out of shape. In another case, the creature had swallowed that beautiful little lively vegetable, the *Euglena pyrum*, and the memorandum I made on the occasion was as follows:—"2nd Dec., 1863. Asplanchna B, young one, had swallowed an *Euglena pyrum*, which at one time came partly up into the œsophagus, stretching it so that it was difficult to tell where the stomach began. Then it arranged itself crosswise at the bottom of the stomach, and the œsophagus, crop, and stomach were stretched

* The ordinary eggs are hatched inside. I saw several young ones extruded, exactly resembling the mother.

so as to form one triangular bag. The *Euglena* was elongated into a cylinder with a pointed tail. At another time the ciliary motions of the stomach made it spin round and round about its long axis."

My present object is to call particular attention to the ciliary stomach currents last mentioned, as I have seen them more strikingly displayed in the asplanchna than in any other rotifer. It would seem as if the whole surface of the stomach were lined with cilia in active motion, and the direction of the currents they occasion, depends chiefly upon the gaps that occur in the masses of food. The motions of the creature agitate and constrict the stomach. Thus the food, when reduced to a pulp, is easily divided into separate portions, and the spaces between them form channels, down which the ciliary currents rush. They are easily seen with a good $\frac{1}{4}$ or $\frac{1}{5}$th, but with Smith and Beck's $\frac{1}{20}$th, (and doubtless also with Powell and Lealand's $\frac{1}{25}$th), they are magnificent objects. It was with the former glass I frequently viewed them, and I find on one occasion the following note entered in my microscopic memorandum book :—

"The stomach of the asplanchna exhibits the ciliary motion very finely—the food gets divided into separate masses, and in the inter-spaces, the ciliary currents look like the confluence of ten thousand waterfalls, and often form whirlpools in which small particles are hurled about with great velocity." No drawings can give anything like a picture of such movements; but a diagramatic sketch was made of the most singular, and I find two closely curled whirlpools working away in juxtaposition, and connected with two parallel currents about a seven hundredth of an inch long, both of which were curled inwards at the bottom, and sent up two steady streams, the tendency of which was to cut another channel through the food mass, and to keep its particles bathed incessantly on every side.

Lower powers easily show that these currents exist, but no idea can be formed of their beauty as a spectacle, unless with such an object-glass as the $\frac{1}{20}$th and careful illumination with the achromatic condenser. As thus displayed it was one of the most striking and memorable scenes of the microscope that I have ever witnessed. Some other rotifers may answer the purpose as well as the asplanchna for showing these currents; but I have never met with one equal to it. The tissues are as clear as our finest glass, and the stomach well-situated. Slight compression should be employed, but not enough to hurt the creature whose internal after-dinner arrangements it is intended to survey.

THE FOUNDATIONS OF PHYSICAL SCIENCE.

We heartily welcome the first volume of the "sixth and completed edition" of Dr. Arnott's *Elements of Physics** because we believe there is no work in any language that can supply its place. Other works of great merit are for the most part† only adapted to those who have already acquired the habits of students, and there is no pleasure in reading them, apart from that attaching to the acquisition of facts in a dry and bald form. Dr. Arnott's famous book is, on the contrary, so admirable for simplicity of statement and elegance of illustration, that no reader, young or old, whose mind is in a condition of reasonable activity, can resist its fascination, or be willing to put it down until it has been carefully read. To those who have everything to learn concerning the physical forces of the universe it will prove a delightful guide, while those who are familiar with the principles it unfolds, will be charmed by the excellence of its method, and by the admirable use it has made of that best of all aids to memory, a natural and comprehensive association of ideas. The writer well remembers the pleasure afforded by an early edition in his schoolboy days, and doubtless many who now occupy important positions in the scientific world will speak of it as one of the few books which contributed to direct their tastes, as well as to lay the foundation of accurate thinking upon the varied problems presented by the external world.

In some respects the most difficult part of Dr. Arnott's labours remains for the second volume, which is promised in October, to conclude the present edition and complete the work. The volume now issued comprehends mechanics, hydrostatics, hydraulics, pneumatics, acoustics, and animal mechanics. "Thoroughly revised," as the author tells us, and "brought up to the present time." The second volume will relate to heat, light, electricity, and magnetism, with astronomy, and popular mathematics. There is a little awkwardness in treating, as this volume does, of boiling water and the steam-engine before explaining the laws of heat; but the matter relating thereto is certainly intelligible to any one who has carefully studied the chapters that precede it.

While generally concurring with the views adopted by Dr. Arnott, we regret that he has placed a particular, and in some respects highly improbable *theory* in the position of his "first fundamental truth." The assertion that "every material mass in nature is divisible into very minute indestructible and *un-*

* *Elements of Physics, or Natural Philosophy, written for General Use*, in Plain or Non-Technical Language, by Neil Arnott, M.D., F.L.S. Sixth and completed edition. Part I. *Longmans.*

† *Philosophy in Sport made Science in Earnest*, is a valuable exception to this rule.

changeable particles," is assuredly not *ascertained* to be true, and there was not the slightest occasion to make a doubtful guess, as in the word we have given in italics, or it may be an erroneous assertion, the foundation of a superstructure built up in accordance with logical rules. So distinctly does Dr. Arnott assert the doubtful doctrines connected with the word *atom*, that he gives as an illustration of the assertion just cited, the case of a piece of metal, bruised, broken, cut, dissolved or *otherwise transformed*, a thousand times, but which still "can always be exhibited again as perfect as at first." Dr. Arnott probably did not intend to convey all that this passage plainly means and implies, and he would surely hesitate to affirm all its unproved assertions, if they were drawn up in due form and presented to his eye. He does not *know* that there are such things, for example, as "indestructible unchangeable particles" of iron. There could only be such particles of simple substances, and who can tell what substance really deserves that name? All compound substances may have an atomic composition—that is to say, they may not be susceptible of division beyond a certain limit without being decomposed; but if so, the smallest possible particle of a compound will consist of two or more still smaller particles of its elements, whatever they may be. The principles of mechanics do not depend upon any of the gratuitous assertions made in Dr. Arnott's so called "first fundamental truth," and it does not coincide with his usually careful and luminous statements concerning either argument or fact.

An accurate knowledge of the elementary principles and facts of physics forms the only possible foundation for the study of more complicated branches of physical science, and it is unfortunately surprising to find how few persons have taken the trouble—or, if Dr. Arnott were the guide, we should say enjoyed the pleasure—of learning these primary truths.

The processes of the human organism develope many forces, but man as a worker creates none; all that he can accomplish is to use his own muscular force, or some other power, so as to accomplish his will. If he boils water and avails himself of the expansive force of steam, he has not made that force. He has merely placed fuel, water, certain masses of metal and other articles so as to be acted upon, in given directions and for a given time, by certain properties of heat. In what are called the mechanical powers (levers, etc.) he does somewhat less, and his action depends upon a few simple principles and facts. This is well expressed in the opening lines of the analysis to the second section of Dr. Arnott's work:—"The bodies or masses composing the universe may be at rest or motion, and to change any present state, force

proportioned to the quantity of the body and to the degree of change is equally required, whether to give motion, to take it away, or to bend it." Every one can see that a body at rest might remain so for ever, if no one, and no thing, exerted the force necessary to make it move; but it is not equally obvious, though equally true, that if once set in motion it would move on for ever, if nothing caused it to stop. Let this truth be felt, and an interesting inquiry must arise concerning what becomes of an arrested force. Science has not yet demonstrated that all forces are correlative; but we are justified in saying that forces are incessantly at work, and that one force only ceases from doing one kind of work by becoming occupied with another kind of work. We recognize a force by what it is doing, or has done, and we give names which designate distinct actions, although they may become erroneous if supposed to designate totally distinct causes. The mechanical force displayed in the swift journey of a cannon-ball to a target, disappears when the object has been struck, and the ball brought to rest; but it has developed great heat, and altered its own internal state, and also that of the target, in addition to the visible effects of crushing and penetration.

Nature is full of practical equations. A small body, moving quickly, equals in force and can counterpoise a larger body moving with proportional slowness. There are innumerable applications of this law; but all are readily comprehensible, provided the manner in which a lever operates is first understood. Ignorance first, and familiarity afterwards, prevents the importance of these simple facts from being perceived; but it is not too much to say, that human existence and civilization would be alike impossible, if small quantities of matter could not be made to balance large quantities of matter, or large quantities made to balance small quantities, by proportioning the quantity of motion imparted to each in a given time. Dr. Arnott puts the question very simply, in explaining that the "apparent paradox of a weight of one pound at the *end* of a beam being rendered through such medium equal in effect to four pounds placed nearer the *centre*, is solved by reference to the nature of inertia and motion. The same amount of force which gives any certain velocity to four pounds is just that required to give four times that velocity to one pound; and owing to the connection of the two weights through the beam, no motion downwards by gravity can occur in the four pounds, without causing a motion upwards just four times as great in the one pound."

The term *inertia* has been so long in use, that there is little chance of getting rid of it; but it tends to give a false idea, which sometimes clings to a student's subsequent thoughts.

A body that does not move because the forces acting upon it are balanced, is not inert in any proper sense of the word. If it be a ball resting on the table, it tends towards the earth's centre by an active gravitation thereto, and it does not go through the table, simply because the cohesion of the wood is greater than the force by which it is pressed downwards. A piece of thin paper held on stretch will support a billiard ball, but a pound weight would go through it. If a body is still, it is so because the forces that act upon it balance each other, and it will move if a fresh quantity of force be added, by which it is overbalanced in any direction. In teaching mechanics, it is advisable that this truth should be borne in mind, and that the pupil should know that the word *inertia* by no means expresses the actual state of the case.

The capacity to be of service in the concerns of practical life depends a good deal upon an acquaintance with the elements of physics, and without that knowledge it is impossible to make sufficient advance in any other science to afford either profit or delight. And yet hundreds of schools still exist, at which boys and girls may pass seven or fourteen years without knowing the difference between a pulley and a screw! For private families the means of pleasurable instruction are supplied by Dr. Arnott's book. It should be read a chapter at a time, and the various experiments performed with articles that exist in every house. Pieces of stick will make levers; everybody can get a common carpenter's screw; a cotton reel is a pulley; a teapot teaches hydrostatics, because the small column in its spout is able to balance the big column in the vessel itself; it will also teach some hydraulics, because, with a given inclination, it will discharge its contents quicker when full, than when, from being partly empty, the level of the source of supply is not so much above the point of exit as in the former case, and consequently the pressure is less. The habit of understanding the scientific principles that operate in daily concerns is an invaluable one. It is astonishing that men have lived so long in the world, and that the most civilized nations are only beginning to find out that it is desirable to know something about it. Without some knowledge of physics and chemistry, without microscopes and telescopes, the mind is half starved, because so little of nature's operations is understood; and there remains a great gulf of separation between the instructed few and the uninstructed many. Far better would it be—and happily not now difficult or costly—for the average cultivation of youth to be carried at least as far as the rudiments of positive knowledge in the departments we have specified, and then the capacities of society for utility and enjoyment would be a million-fold increased.

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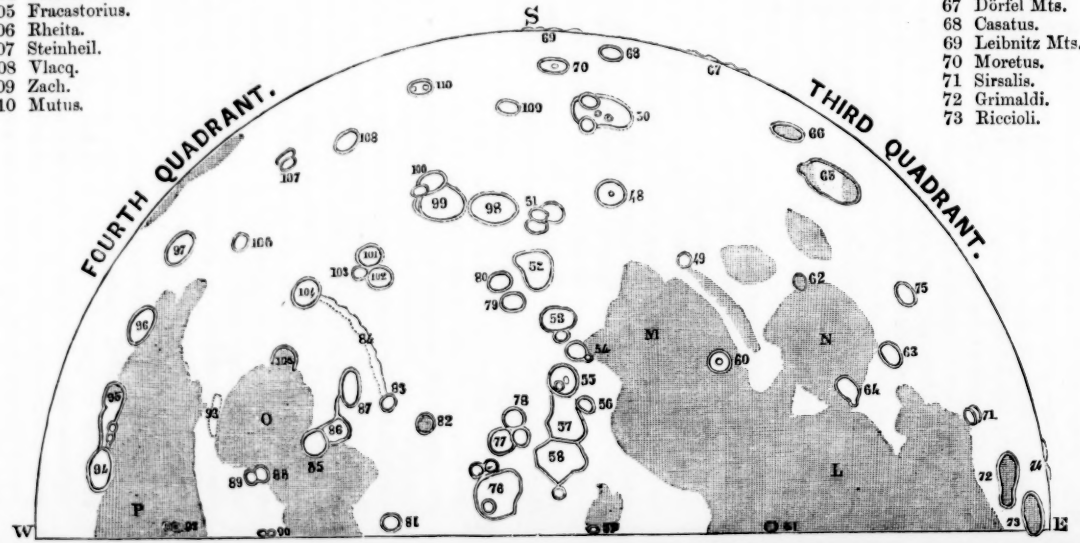

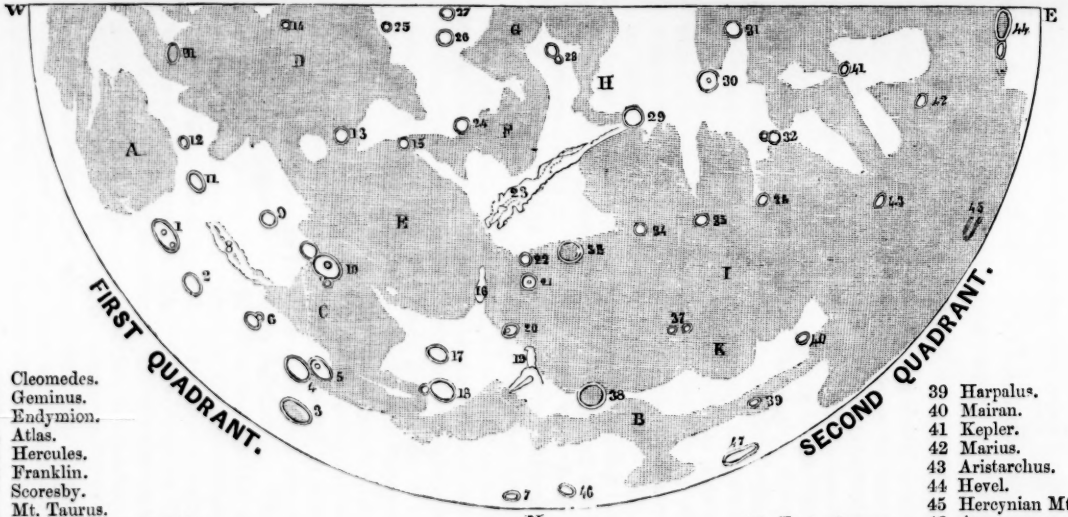

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THE MOON. PLANETS OF THE MONTH. DOUBLE STAR. OCCULTATIONS.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

INDEX-MAP OF THE MOON.

THE accompanying diagram of the moon is not intended as a pictorial representation of the surface of our satellite, but as a guide to the position of the more conspicuous spots or interesting regions; and beyond this it makes no pretensions.* From the principle of selection which has been adopted, it is hoped that it will be less perplexing to the amateur who is commencing the study of our satellite, than if it were a crowded reduction of a larger map; and while it will assist him in acquiring the nomenclature of the principal features, its more express object will be to enable him to identify the position of the details which it is intended to describe successively in future papers. It has been divided into two halves, in order to avoid the inconvenience of folding; and bisection in an E. and W. direction has been preferred to the more natural one from N. to S., as interfering with much fewer objects. This, however, has entailed the necessity of turning the diagram on its side, that it may present an aspect similar to that of the full moon in an inverting telescope. The grey plains, or so-called seas, are distinguished by Roman capital letters, the craters and mountains by Arabic numerals, corresponding with the accompanying list, which, it will be observed, has been so arranged as to bring the designation as nearly opposite as may be to the spot to which it belongs. The great work of Beer and Mädler being adopted as the standard authority, their order has been followed in the distribution of the numbers, though its appropriateness may not be in every instance as apparent as might be wished. The student is recommended to pay especial attention to the situation of the points of the compass, which differs materially from that recognized almost universally in terrestrial maps. The reason of this peculiarity will be clear if the diagram is turned upside down; it will then represent the full moon as seen on the meridian without a telescope, and the designation of each part of the lunar disc will be found to correspond with the points of the terrestrial compass on every side. This semi-inversion, which arises from our standing face to face with the object, and is exactly that of a common looking-glass, or a front-view

* A much more complete map, twelve inches in diameter, containing every spot included in the nomenclature of Beer and Mädler (404 in all), will be found in the author's little work entitled *Celestial Objects for Common Telescopes.*

reflector, will be a little puzzling at first, and should be thoroughly mastered in order not to get bewildered and lose our way in following the description of details.

We are now prepared to enter upon an individual examination of the most conspicuous wonders of our satellite; a few preliminary remarks, however, may be expedient, to put the student in possession of such information as he may subsequently find useful. With regard to the lunar nomenclature, this, though now reduced to a settled arrangement, has been formerly subject to great variation. Hevel, the celebrated observer of Dantzig, who flourished during the latter half of the seventeenth century, was the first to designate the various regions and spots by names; these he derived from some kind of analogy between the configurations of the terrestrial and lunar surfaces—occasionally a tolerably happy one, but generally speaking very inappropriate, as well as inadequate to meet the future requirements of advancing knowledge. His successor, Riccioli, though an inferior observer, improved considerably upon this method, by the adoption of Hevel's earlier idea, which had been abandoned from the fear of apparent partiality, and which consisted in the employment of the names of eminent scientific men—among these taking care not to forget *his own*. He changed, at the same time, Hevel's appellations of the so-called seas, for others referring to supposed influences exercised by the moon upon the atmosphere and productions of the earth, and altered in a similar way those of the higher districts and mountain ranges; but in the latter case his designations have fallen into disuse, or have, in a few instances, been unable to supplant the earlier ones. Fortunately for Riccioli's scheme, it is of an elastic character; the constant increase in the number of scientific names admitting of its extended application in proportion to the increased number of spots which modern accuracy seeks to distinguish; such an extension is, in fact, being carried out at the present time by our own zealous and able selenographer, Mr. Birt; and this nomenclature may now be considered as established beyond the prospect of change. As, however, it would be obviously impossible to find separate designations in this way for all the objects which require to be identified, Schröter introduced the use of the letters of the Roman and Greek alphabets for the minor details in each of his "selenotopographical" plates; and this plan has been reduced by Beer and Mädler to a regular system, which it may be desirable to explain in this place, as their letter-press is not always in the hands of the possessors of their map. Every object which has no proper name is referred to the nearest spot so designated; if a mountain, it is indicated by a Greek, if a hollow, by a Latin

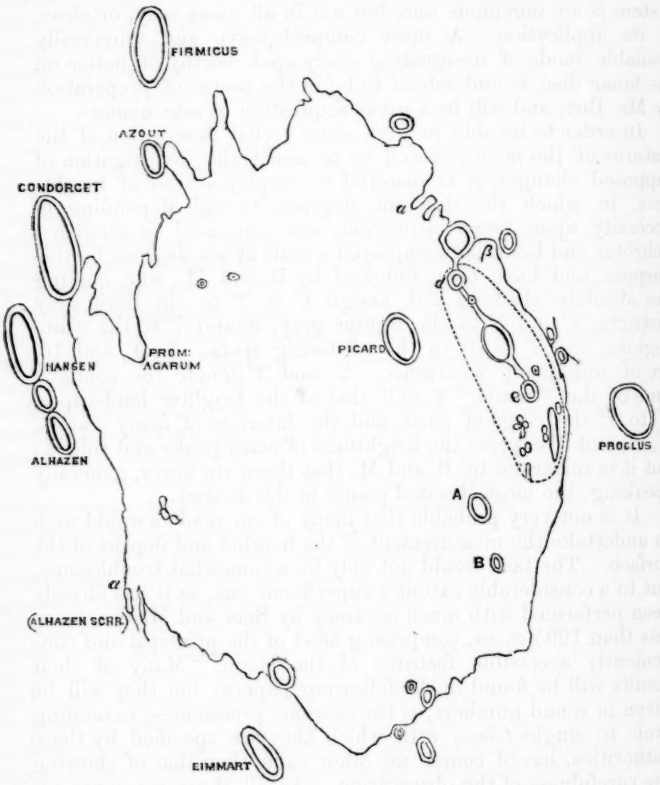
letter subjoined to the name of the principal spot; capital letters are employed for points whose position has been determined by measurement, smaller ones for such as are filled in by the eye; these letters standing, especially when so required, on the side of the object next to the spot whence it is named; and the alphabetical succession being determined by the relative conspicuousness of the features when best seen. The system is an ingenious one, but not in all cases easy, or clear, in its application. A more comprehensive and universally available mode of designating every spot worthy of notice on the lunar disc, is understood to be in the course of preparation by Mr. Birt, and will be a great acquisition to astronomers.

In order to be able to give some verbal description of the features of the moon, as well as to assist the investigation of supposed changes, it is material to employ a scale of brightness, in which the different degrees, though depending of necessity upon mere estimation, are expressed by numbers. Schröter and Lohrmann employed a scale of ten degrees for this purpose, and have been followed by B. and M., who, making the absolute shadows = 0, assign 1° to 3° to the dark grey districts, 4° and 5° to the lighter grey, 6° and 7° to the white regions, and 8° to 10° to the glittering spots. 1°, 9°, and 10° are of infrequent occurrence. 2° and 3° denote the common tone of the "maria," 4° to 6° that of the brighter landscapes, 4° to 7° the rings of most, and the interiors of many craters, 6°, 7°, and 8° express the brightness of many peaks and ridges; but it is remarked by B. and M. that these are never, generally speaking, the most elevated points in the district.

It is not very probable that many of our readers would wish to undertake the measurement of the heights and depths of the surface. The task would not only be a somewhat troublesome, but to a considerable extent a superfluous one, as it has already been performed with much accuracy by Beer and Mädler, in no less than 1095 cases, comprising most of the principal and conveniently accessible features of the moon. Many of their results will be found in the following papers; but they will be given in round numbers, as the extreme preciseness, extending even to single *toises*, with which they are specified by those authorities, has of course no other value than that of showing the carefulness of the observation. As all these measures are determined by the lengths of shadows, a trifling difference, as to which we have very little means of judging, in the level of the ground where the shadow terminates, will have so great an influence on the final result, that no such exceeding accuracy is possible. No doubt, much might yet be done, if it were thought desirable to obtain more perfect correctness, by taking the average of many measures, obtained at different times from

different lengths of shadow; and should any observer, possessing a good micrometer, and facility in the use of it, wish to offer such a contribution to selenography, he will find all the necessary formulæ in *Der Mond* (The Moon) of Beer and Mädler.

As to the instrument to be employed, many of the lunar features are so conspicuous, that any good telescope will suffice



[The above diagram of the Mare Crisium contains the principal features in the map of B. and M.; the portion, however, surrounded by a dotted line is altered to correspond with my own observations.]

to show them. Of course, a larger instrument would be preferable; but even a 2-inch object-glass with a good astronomical eye-piece will reveal wonders enough to be a constant source of interest. In the case of a very large aperture and an

eye sensitive to light, much comfort may be experienced from the adoption of a screen-glass, such as is used for solar observations, but, of course, of a much lighter hue: a pale green has been recommended by Challis as very suitable. High magnifiers are seldom of much value; they contract the field unpleasantly, and increase the apparent motion of the object, unless a driving-power is at hand. From 100 to 300 times may be mentioned as most generally serviceable. Beer and Mädler never exceeded the latter in their original investigation with an aperture of nearly $4\frac{1}{2}$ inches, though Mädler, after succeeding W. Struve at Dorpat, employed powers of 600 and even 1100*, with the great achromatic of 9·6 inches, in that observatory.

We begin with one of the most familiarly-known spots, the—

MARE CRISIUM.

The remarkably well-defined grey plain, marked A in our Index-map, has received from Riccioli the name of Mare Crisium,† "the Sea of Crises," by which, as there is nothing of an astrologico-political character in his nomenclature, he probably meant changes of weather; and, if so, has, as far as he could, commended it to the especial attention of English astronomers. It is so distinctly and strongly bounded as to be always easy of identification, lying near the W. limb, and not far N. of the lunar equator: and we cannot wonder at the impression of the earlier observers, who imagined, in such a striking level, the exact counterpart of a terrestrial sea, or great lake encircled by a rampart of mountains. Such, however, was not the full conviction of Hevel, though he adopted the name as the closest approximation that he could find; and such an idea will not be revived in the present day, so multiplied and so distinct are the roughenings of the surface which modern instruments will show, and so clear the view into the depths of craters, which would be the chief receptacles of any fluid existing there.‡ The "Mare" before us is evidently a very interesting one; its oblique position, however, subjects it to so great a foreshortening that its interior is studied to much less advantage than if it occupied a more central situation. From its nearness to the edge of the disc its apparent form is much

* These were, however, probably much exaggerated. Encke found that the 600 power on a similar achromatic at Berlin, by the same maker, proved to be only 400 by the dynameter.

† Certainly little imagining that any future astronomer would ever quote its genitive case as "Mare Crisii," which, however, B. and M. have done in one instance, p. 194.

‡ Arago, however, thinks this inference not conclusive, as the uneven, craggy bottom of our oceans may be distinctly seen from a great height. It might be added that fresh water would be still more translucent.

affected by libration; its measure from E. to W. varying at different times from 0·6 to 0·8 of that from N. to S. Its general appearance is that of an irregular oval extended along the lunar meridian, and we should not have supposed, from mere inspection, that in consequence of the perspective foreshortening it is actually elliptical the opposite way, its longer axis pointing towards the eye, or more correctly from W.S.W. to E.S.E. of the lunar compass. In this direction it extends nearly 354 English miles; from N. to S. about 280 miles, or about the distance from London to Newcastle. Its area is about 78,000 square miles,* $\frac{1}{111}$th part of the visible hemisphere of the moon, ten times the surface of Yorkshire and Lancashire united, or a little more than half as much again as the area of England and Wales, though of a very dissimilar form. Of this, however, only $\frac{3}{5}$ths can be considered level. Its border is not everywhere continuous, being interrupted in some places, especially towards the W., on which side narrow arms or straits penetrate the mountains, and communicate with smaller grey surfaces. No "sea" is equally dark in comparison with its mountain boundaries, having generally only 2° to $2\frac{1}{2}$° of light, grey in tone, mingled with dark green; but the latter colour, according to B. and M., for I have never seen it, is perceptible only a few days before and after the full moon, with a large aperture, a moderate power, and very favourable weather, and, except near the *Promontorium Agarum*, nowhere extends to the W. limit. It has been represented by Professor C. Piazzi Smyth, in his three general views of this surface, sketched with the feeling and spirit of a genuine artist, but entering little into detail. "Practice and experience," he says, "brought to view so many decided and interesting features of colour," that the idea of employing black and white alone had to be abandoned. The surrounding region ranks as 5° of light, in some spots rising to 6° and 7°. Mountains encompass it all round, attaining a considerable height on the NE. side; here, in a line passing through *Picard* A and B, B. and M. have measured a summit of 13,300 feet, and further to the S.S.E. others of 7,150, 11,300, and 6,700 feet; these decline at once precipitously to the plain, from which they must exhibit a magnificent spectacle, and over which they must command a marvellous prospect. Such views are of frequent occurrence in the moon, and the rapid rounding-off of so com-

* Something appears to have gone wrong here in the text of B. and M., as, assuming their length and breadth to be correct, the area they have given is considerably too small. I have corrected this; but am sorry to add that something has gone much more wrong in this place in my little book, entitled *Celestial Objects for Common Telescopes*, where, from using an erroneous multiplier, I have made the area only 14,260 square miles! I find, however, a similar mistake in *Cosmos*, iv. 492 (Bohn).

paratively small a globe, and the sharpness of outline and detail consequent upon the absence of a vaporous atmosphere, must give them an effect which would seem very astonishing to a terrestrial spectator. Further to the S. this E. coast declines to a kind of pass, not well shown by B. and M., who admit that this part of their map is deficient in boldness, but much better drawn by Schröter: on the other side of this interruption the mountains rise again, and on the S. the great summits *Picard* α and β spring up to 14,200 and 15,600 feet, rivalling our loftiest Alpine peaks; beyond these the great headland, named *Promontorium Agarum* by Hevel, runs out into the plain with a rounded summit nearly 11,000 feet in height, supported by cliffs 8° bright a few days after the full, when they are most directly enlightened. Birt has detected a crater upon it. In this direction broad bays and "fiords" penetrate the mountain border towards the S., and in the young crescent are filled with shade. The W. edge of the "Mare" is less boldly defined between the craters *Condorcet* and *Eimmart*, and is made up of hillocks and ridges, intermixed with isolated mountains, like lofty islands in the sea.

It was among these that Schröter found a distinct and always recognizable crater, about twenty-three miles in diameter, remarkable for its dark grey colour under every angle of illumination, to which he gave the name *Alhazen*, and which, from its proximity to the W. limb, he continually used for the purpose of measuring the libration. Having thus had it constantly before his eyes, he was the more surprised at its variable aspect: at first it was a depressed grey surface within a ring; then frequently, and even in the 27-foot reflector, like a longish flat ridge, and these appearances were interchangeable; sometimes, too, while the neighbouring objects were as sharp as usual, it would be so indistinct that "he did not know what to make of it:" and on one occasion (1797, March 1), after ten years of observation, when libration was most unfavourable, as having carried its W. edge to within 28″ of the limb, and the terminator had crossed over to the other side of the "Mare," and it consequently ought to have been very ill seen, he found it extraordinarily distinct: its form, however, was one previously entirely unknown, that of a very deep bright irregular crater, whose ring was barely complete towards the S., and open, with a prolongation of its E. edge, at the opposite end. The cause of this difference, he thought, must lie in some modification of the lunar atmosphere, such as he believed that he could trace in many instances, which would be capable of masking the depths of a crater, and giving it a grey and flat aspect, or changing altogether its appearance. In Bode's *Jahrbuch* for 1825, Kunowsky, an accurate observer, asserted

that *Alhazen* was no longer to be found under any form, and that the region seemed quite different; nor did B. and M. come to any other conclusion. They could discover no ring-shaped mountain there—on the contrary, an abundance of partly isolated, partly connected hills and mountains, and long, dark, curved valleys and bays; so, knowing the "great uncertainty"* of Schröter's drawings, they fixed upon a crater considerably further S. to bear the name, as it seemed to correspond best with Schröter's object. On the other hand, Pastorff and Harding stated, in the *Jahrbuch* for 1827, that they could always see *Alhazen;* and Köhler, under the year 1828, asserts that it has not disappeared, but is very variable in aspect; and he has given several figures showing that it corresponds with B. and M.'s *Alhazen a,* the loftiest mountain in the region, 7700 feet above the valley to the W. On the E. side of this height, between it and some low ridges, lies a deep hollow, with openings to the "Mare," the colour of which varies with its illumination, while the mountain itself might, from its shape, sometimes take the aspect of a ring. And with this B. and M. seem satisfied, notwithstanding their having changed the name. At the commencement of 1862, Birt recovered this spot, exactly in the position given by Schröter, and has described it in detail as a deep valley between two mountain ranges, of which the W. (*a* of B. and M.) is much the higher: these are quite separate at their S. end, but under many circumstances are barely distinguishable from the ring of a crater. On the E. side of *Alhazen,* where Birt perceived one or two minute craters, Gruithuisen fancied that certain rows of hillocks might contain the habitations of Selenites! and here, too, he noticed rapid changes from bright to grey under increasing sunshine, which, being contrary to photometrical principles, he was disposed to refer to cultivation. Fanciful and absurd as his speculations often are, we should not do right in systematically rejecting his facts, some of which may be worthy of further investigation.

* That there is occasional cause for this censure need not be denied, though coarseness and rudeness of delineation would be a more appropriate characteristic. But still the old Hanoverian astronomer was far from always deserving the disparaging remarks of his successors. For instance, they have brought it as a charge against him that he drew the *Mare Crisium,* "with all its environs," in a single evening, and has given it a bordering so unlike the truth, that it is scarcely sufficient for its recognition (a bold and strange assertion), and is quite useless for the identification of details; and they ask how it is possible on such data to found ideas as to the existence of atmospheric or volcanic changes. It would hardly be supposed that Schröter's own expressions are, that as a single evening is too short for the examination, measurement, and delineation of such a region, and it would be wrong, and misleading, to piece together separate drawings taken under different circumstances, his sketch is expressly confined to the interior level, and the remarkable objects in the mountain border, but that the latter is merely laid down in a general way.

The grey interior plain contains many irregularities of surface, of which the principal is a crater called *Picard*, at least twenty-one miles in diameter. *Twenty-one miles!* what a scale this gives the lunar student in gazing at this marvellous landscape! A spectator stationed here would see the earth like a great globe, between three and four times of the apparent size of the moon to us, standing at an elevation of about 34° in its W.S.W. sky, passing through all the varied phases of the moon, and only shifting its place a little in consequence of libration. The sun, on the contrary, reaches 74° to 77° of altitude at noon, and the interior hollow is for 120h. a shadowless and, as we should suppose, an oppressively burning basin. It is surrounded by a tint somewhat darker than that of the rest of the plain, above which its W. wall ascends 3050 feet, but 5300 above the bottom of the crater. Schröter has given the latter at least 3000 feet more, but no measures can be trusted taken under so unfavourable an angle. The smaller craters, *Picard* A and B, are steeper and deeper, and retain almost all their shadow when it is quitting their more imposing neighbour. Within the line of the E. coast lie several high mountains, either isolated or connected by low ridges, as is frequently observed in the moon. These are so ill-represented in the great map of B. and M. that they have given a special drawing with the letter-press, full of minute detail. Like all their delineations towards the limb, it suffers materially in effect from the attempt to represent both sides of every mountain as in a bird's-eye view, when one side only is visible in perspective. It would not, indeed, have been practicable to avoid this, while persevering consistently in the conventional style adopted in maps; but the result is unfavourable in all situations lying obliquely to the eye. Independently however of this awkwardness, for which the observer must learn to make allowance, I am obliged to remark that I cannot succeed in reconciling it with what I have seen in the same region, and have roughly indicated in the accompanying diagram. One of these mountains which B. and M. have designated *e* (affixing the letter, however, in their large map not to the proper object, but to a mountain about $\frac{3}{4}$° N.N.W.), terminates a low serpentine ridge running up from the crater *Picard d*, and contains, beneath its summit (the loftiest point in the neighbourhood,* 5500 feet above its W. base), a distinct crater, first represented by Cassini; of the existence of this there is no question: but its W. is so much higher, broader, and brighter than its E. wall

* Schröter however rates it differently. He gives it 4982 feet, but thinks some of its neighbours higher. I have also noticed it not casting the longest shadow; but in this there is much uncertainty, for want of an uniformly level base.

that under many angles of illumination it assumes the appearance of a long mountain ridge. Such is the explanation offered by B. and M. (after Kunowsky) of the singular changes in form and shading which long perplexed Schröter, and which led him to infer atmospheric if not volcanic changes; and it seems probable that in this instance the more modern astronomers have the best of the argument. The question however is not altogether clear. Schröter's observations upon this group of mountains are too numerous to be recited here; they refer chiefly to the varied appearance of shadows, longer, shorter, imperceptible, or unusually directed, at different times, but under nearly similar angles of illumination; to unaccountable changes in the forms of mountains; and to the discovery, and subsequent invisibility, of ridges or hillocks in well-known and often observed situations. There can be no doubt that, as he was himself aware, a slight difference in the conditions of illumination and reflection may produce a very disproportionate change of aspect; still, there is much weight in his remark that this must not be pushed too far, or we should find similar variations occurring from the moon's progress during the course of a single observation extended through several hours, which has never yet been found to take place. To one source of error he was perhaps not sufficiently alive—the increased perception of the true nature of a distant or obscure object, in proportion as it becomes familiar to the eye. It certainly does not seem at all likely that the crater *e* was ever seen in actual eruption by Schröter, as he was inclined to suppose; but we must bear in mind that, as eruptions of some kind—whatever that kind may be—must have taken place upon the moon times without number, there is no antecedent impossibility in such an idea. It must be admitted that the region is a curious one, and well adapted for an inquiry which may be worth the while of future observers, whether all these variations are due solely to differences of illumination and libration, or whether there may be, as Schröter supposed, occasional modifications of a lunar amosphere, capable under certain circumstances of impeding or perverting our view; and it would be unphilosophical and unwise to allow the greater probability of the former alternative to stifle the inquiry. In order to bring out of it any successful result, Schröter's observations would lead us, not merely to note the aspect of the crater *e* in all positions relative to the sun and earth, but also to examine the proportionate lengths of the shadows of the other mountains in the group, and the first and last appearance of their summits at the time of lunar sunrise or sunset. My own observations have not been sufficiently consecutive to be of real service in establishing anything. To the general reader much that has

been here brought forward may appear of trifling interest, but as there is reason to believe that selenography is now receiving a powerful impulse, it may be useful to the student to know what difficulties and uncertainties may attend his own path, and what has, or has not, been done to remove them. He will not regret having made acquaintance with them at his first essay.

We must not omit some other curious observations which include a more extended range. Such was that of Schröter, who upon one ocasion, when the moon was 2d. 23h. old, found the whole W. portion of the "Mare" unusually bright, and of a yellowish hue, so as scarcely to be distinguished from its mountain border; this appearance, unprecedented here, or in any similar level, fading away entirely into the ordinary grey on the opposite side of the plain. At another time, the moon's age being 6d. 7h., he saw "an incredible, innumerable multitude" of bright specks in the grey surface, chiefly in places where no known object existed. A subsequent examination of other grey plains, under a similar incidence of light, showed him nothing equally remarkable. More than two years afterwards, however, under a very different and almost vertical illumination, the moon being 11d. 19h. old, the scene was renewed; the plain was so interwoven and variegated, like the veins of an animal, or an irregular tissue, with streaks of light, and actually innumerable bright points, that it would have been difficult for the most skilful artist to give a sufficiently striking representation of such a magnificent scene. Two days afterwards this beautiful effect had disappeared, and nothing of the kind could be traced in the *Mare Serenitatis* on the neighbouring levels, where the sun had by that time attained a corresponding elevation.* No other similar instance was ever recorded by him; but the following from B. and M. (who characteristically ignore what he has described) was evidently one of the same nature. The moon being between 10d. and 11d. old, they noticed that the greater part of a white streak which runs from *Proclus* (No. 12 in the Index-Map) towards *Picard* B was resolved, through an area of 230 miles by 28, into fully 150 points of light, like a jet of water dispersed into spray—the whole plain appearing also more speckled than usual. I was once (1832, July 4) so fortunate as to witness something of the kind, about the time of first quarter, when the whole plain, notwithstanding the imperfection of my instrument—a fluid achromatic of four inches, upon Barlow's plan—was seen beautifully mottled with light and shade, a spot at the N. extremity nearly rivalling the brightness of *Proclus*. It is

* But from which the rays would be reflected at a very different angle to the spectator—a circumstance which Schröter does not notice.

certainly not easy to account for the infrequency and uncertainty of such observations. B. and M. could occasionally perceive, in very clear air, a multitude of the minutest points just on the night-side of the terminator, indicating a surface less perfectly level than it might otherwise appear. They could trace also, from their shadows, ridges of about 60 feet in height, and $2\frac{1}{2}$ to 4 or 5 miles wide. There are many more considerable ridges in the plain, running generally from N. to S., branching and reuniting, rising to knolls at their intersections, and sometimes enclosing circular hollows. The remarkable peculiarity to which Schröter paid so much attention, as existing everywhere in the moon, that these ridges form lines of communication between more conspicuous objects, is not without examples here.

A few other features remain to be described. Olbers discovered, with a $3\frac{3}{4}$-inch Dollond, in 1794, two minute craters between Picard and Condorcet. Five more of very trifling depth are mentioned by B. and M. in the same region, but not drawn, having been detected after the publication of this part of the map. The *Mare Crisium*, indeed, is executed altogether in an inferior way, as though it had been an early attempt. They have omitted a few minute craters figured by Schröter near the W. and N. border; and many of these objects are of such difficult visibility that discrepancies must here cause no surprise. Nevertheless, insignificant as they may appear, they are of much value to the selenographer, as they admit of close comparison with regard to relative size, and consequently afford an especially fair prospect of discovering the progress—should it exist—of eruptive action.

Picard d, a crater discovered by Cassini at the S. end of the serpentine ridge, was noticed by Schröter to be of extraordinary depth, deeper than *Picard*, from its long retention of shade.* Immediately S. of it lies a curious object first perceived by him, an ancient looking ring with a central mound, resembling much a walled plain—such as we shall be introduced to hereafter—in a state of degradation and decay. He could not always find it afterwards, though under corresponding circumstances, and hence was led to infer some atmospheric obscuration. Although B. and M. have introduced abundant details in this district, some of which I have not seen, they failed to notice that the curve which the winding ridge, so frequently mentioned, forms towards the E. is in reality the half of a circle (projected of course as an ellipse), of which I have distinctly made out the remainder, as sketched in the diagram.

* This observer has noticed that many of the smaller class of craters are so remarkable on this account that there is cause to suspect some illusion, as true shade could hardly remain so long. This may be a point worthy of attention.

It is of a character which we shall not unfrequently meet with in our lunar travels, resembling a bowl nearly full of a fluid into which it is obliquely sinking; in point of size and age it seems more the counterpart than is represented in the diagram, of the circle already mentioned on the other side of *Picard d*. I first perceived it, 1863, Oct. 28, and have since repeatedly seen it, under such varied incidence of light, that I cannot doubt its reality, or understand how it is to be satisfactorily reconciled with B. and M's. detail here. They have also omitted two very minute craters, one a little way S.S.E. of *e*, where they, Schröter, and myself at other times have seen an elevation; the other between my ring and *Picard d*, lying apparently on the serpentine ridge, in a part which was not visible when the diagram was made, but is readily seen under the opposite illumination. The pass or gateway through the E. mountains is guarded, as I have several times noticed, by two small craters, both seen by Schröter, but one only clearly represented by B. and M. That on the N. side was not perceived by the former observer till after he had had the spot under his eyes for more than three years; yet there is no reason to suppose it new; such oversights are not very uncommon.

B. and M. have remarked it as a singular fact, that no central hill is to be found in any of the craters in or around this great plain, the nearest so characterized being *Taruntius* and *Macrobius* (91 and 11 in the Index-Map), if we except a feeble and somewhat uncertain trace in *Azout*. I have, however, entered a low central hill, as visible in *Picard*, and another more distinct in *Picard* A, with a $3\frac{7}{10}$-inch aperture, 1834, Sept. 19; and with my present telescope I distinctly found, 1863, Oct. 28, that both these craters have interiors rough with hillocks, especially A, which has an irregular mound lying on the inner slope of its N. end; the effect being much as though masses of soft mud had been thrown at random into the interior. Gruithuisen states that near *Picard* some remarkable white ridges are to be seen, in part as straight and regular as artificial walls.

In consequence of the great differences resulting from libration, no certain age of the moon can be mentioned as the most suitable for the study of this region. Opportunities must be carefully watched in the young crescent and the early wane. A grand effect is produced during the progress of the lunar sunset, when the great boundary mountains on each side of the E. gateway fling their ponderous shadows to the terminator, inclosing a small portion of the plain, which still enjoys the declining ray. This has been well figured by Schröter, and I have seen it 3d. 4h. after the full moon.

PLANETS OF THE MONTH.

We have so long been without the charm of planets in our evening skies, that we shall hail their return with pleasure during the present month. Jupiter and Saturn have now come back to us. Saturn will be in opposition to the sun on April 4, and therefore on the meridian at midnight, between *α* and *γ Virginis*, but some way N. of the joining line. His rising will be then about 6½h. The ring is becoming broader every season—its proportions being now about 43½″ by 29″, so that its marvellous details are coming fairly into view, while the intersection of its outline with that of the ball renders the combined form more elegant than it would be with a wider opening. Jupiter rises later, about 9½h. in the middle of the month, and has, unfortunately, a considerable S. declination among the stars of *Libra*. Those who are interested in the study of his features, or the transits of his satellites, will nevertheless, no doubt, attempt to renew their observations. The transits before midnight will be the following:—April 8th, I. will leave the disc at 11h. 44m.—10th, the shadow of II. will enter at 11h. 12m., the satellite following at 12h. 41m.—15th, I. will enter at 11h. 18m., its shadow being already on the disc.

Mercury will be at his greatest E. elongation at the end of the month; and though not in the most favourable part of his orbit, the great eccentricity of which makes much difference, yet, having considerable N. declination, there will be a chance of his being fairly visible in the evening twilight.

DOUBLE STAR.

Saturn will be lingering so near one of these objects during this month, that it would seem strange not to include it in our list. It will be found a little *sf* the planet, and is—

123. *ϑ Virginis*. 7‴·1. 345°·2. 4½ and 9 (1831·15). Pale white and violet. An optical pair, rendered triple by the addition of a third 10 mag. star, at 65″ and 295°. It is a pretty though minute object. I thought the closer attendant greenish or bluish, with 3 $\frac{7}{10}$ inches, 1856·35; but a larger aperture is necessary to estimate the colour of such feeble points, and I have not examined it with my present means.

OCCULTATIONS.

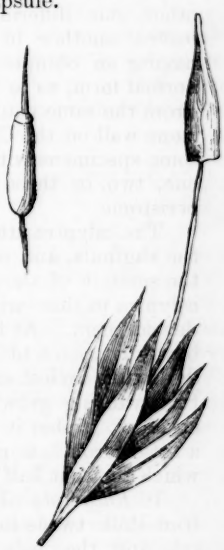
April 11th. χ^2 Orionis, 6 mag., will be hidden from 6h. 28m. to 7h. 38m.—20th, *g* Virginis, 6 mag., from 8h. 40m. to 9h. 48m.—22nd, B. A. C. 4896, 6 mag., from 9h. 23m. to 10h. 25m.

THE EXTINGUISHER MOSSES.

BY M. G. CAMPBELL.

The *Encalyptæ*, or Extinguisher Mosses, form a very natural group, which, notwithstanding the extremely variable peristome, are easily distinguished from all others by the structure and comparative size of the calyptra, which is cylindrico-campanulate below, longer than the capsule, and with a rather long rostrum, like a little tower or round spire at the apex, while at the base it is usually fringed, torn, or crenate, and is persistent, defying wind and rain, and falling away only with the lid when the spores are perfectly ripe. These spores are granular, and of a yellowish-brown colour. The species may be found growing on dry or moderately moist rocks, and on walls and stones, especially those of calcareous origin. The stems are branched, here and there beset with radicles, erect, bearing terminal seta, and perennial; the fruit-stalk is so firm and tenacious as to remain on the stems for several seasons. The generic name is derived from *ἐν in*, and *καλυπτὸς*, covered, shrouded, or enveloped, *i. e., covered in*, in allusion to the persistent, bell-shaped calyptra entirely enclosing the capsule.

The most generally met with is *Encalypta vulgaris*, or the *common extinguisher moss*, of which we give a considerably magnified illustration, with a naked capsule still more magnified, and having on its lid, with long tapering beak. The moss may be found growing on stone walls, also on banks and rocks, especially such as are of calcareous nature. It has rather short stems, rarely half an inch long, but branched and radiculose. Its leaves are erect, more or less spreading, and, in general, more or less apiculate, though in one variety they are obtuse and concave at the apex; the margin plane, crenulate, or scabrous with papillæ; the nerve strong, purplish, often more or less excurrent, but sometimes ceasing below the apex, and the leaves are somewhat crisped when dry. The capsule is subcylindrical, smooth when moist, but frequently more or less plicated or rugose when dry; of thin texture, and somewhat tapering from the base. The annulus is simple and persistent, and being coloured at an



ENCALYPTA VULGARIS.

early stage, is easily seen through the semi-transparent, greenish calyptra, which is papillose at the apex, and said to be entire at the base, though usually more or less torn in its separation from the vaginula, but it is never fringed as in *Encalypta ciliata;* and is entire in the sense of being *of one piece*, self composed, as well as in the botanical sense of being without teeth or notches in the margin; it resembles a little fairy extinguisher placed over a miniature wax-taper, as much as to say, "You must not be lighted till the boisterous winds of March, and the tearful days of April, give place to serener skies and a dryer atmosphere;" but during these months, March and April, the fruit is ripening, and towards the end of April or early in May, extinguisher and lid, which have been such close friends during all the rough weather, fall off together, and give the now matured spores, which are rather large for the size of the moss, leave to escape and develop the functions of vitality that lurk within them. The peristome is frequently absent, and at all times is extremely fugacious and fragile; when perfect, it consists of sixteen teeth, pale and sub-erect, seldom rising much above the orifice of the capsule.

There are several varieties, slightly differing from each other, one differing only in an elongated stem and larger leaves, another in having the leaves piliferous, another in having an oblique capsule, but all so nearly resembling the normal form, as to be easily recognized for *Encalypta vulgaris*. From the same patch, a few yards in extent, and growing on a stone wall on the Cotteswold range of hills, we have gathered some specimens with a full mouth of sixteen teeth, others with one, two, or three only, and others again quite destitute of peristome.

The calyptra attains its full size before its separation from the vaginula, and even before the fruit becomes appreciable at the summit of the fruit-stalk, which is coiled up within the calyptra in this early stage, and it is interesting to witness its development. At first the base of the calyptra is turned up inwardly upon a little mass of spongy tissue, which crowns the depressed conical summit of the vaginula, and when torn away by advancing growth, it is found too firmly adherent to come clean off, so that it leaves a circular fragment from its base, like a little coronet, to crown the vaginula. The reddish fruit-stalk, which is about half an inch long, twists towards the right.

In *Encalypta ciliata*, or the *fringed extinguisher moss*, the fruit-stalk twists towards the left, the vaginula is sub-cylindrical, and the pale yellowish, smooth calyptra is distinctly fringed at the base, the fringe being derived from the spongy conical mass of cellular tissue which surmounts the vaginula, and, therefore, being of laxer texture, and paler than the calyptra

itself. This fringe is inflexed when moist, and is sometimes deciduous.

The capsule of *E. ciliata* is of a bright chestnut colour, sub-cylindrical, very smooth, slightly constricted below the mouth, but without an annulus, and having thicker walls than those of *E. vulgaris*. The teeth of the peristome, lanceolate in form, and sixteen in number, are marked with transverse bars, somewhat prominent externally, and inserted below the orifice of the capsule; they are of a reddish hue, converge when moist, but remain erect in a dry state. The spores are granular, and the fruit-stalk, instead of being reddish as in *E. vulgaris*, is yellow. The stems are loosely tufted, about half an inch long or more, branched and bearing oblong-ovate leaves of a brighter green than those of *E. vulgaris*, broader and less crisped when dry, the margin plane in the upper part, distinctly recurved below, somewhat crenulate at the apex, and with an excurrent nerve forming a slight mucro.

The fruiting season of *E. ciliata* is two months later than that of *E. vulgaris*, viz., June and July. It is found on rocks in the mountainous parts of England, Scotland, Wales, and Ireland. In both the inflorescence is monoicous, as is the case with *Encalypta commutata*, and *Encalypta rhabdocarpa*.

E. commutata, or the *sharp-leaved extinguisher moss*, has also branched and radiculose stems, which are slender and about an inch long, with ovate-lanceolate leaves, concave, acuminate, slightly undulated, more or less spreading and squarrose from an erect sheathing base, and having an excurrent nerve.

The capsule is smooth, sub-cylindrical, of thinnish texture, and seated on a reddish fruit-stalk. It has a simple annulus, but no peristome; and the calyptra is smooth all over, jagged and uneven at the base, but not fringed. The vaginula, as in *E. vulgaris*, is crowned by a conical cap of spongy tissue, whose base is bordered by a circlet torn from the base of the calyptra.

The barren flowers of *E. ciliata* are found near the perichetium, they are gemmiform, but only three leaved; those of *E. commutata* are six-leaved, and are either axillary, or terminal on a branch, accompanied by numerous antheridia and paraphyses; but *E. commutata* is sufficiently distinguished by its taper-pointed squarrose leaves, which are its unfailing characteristics. It appears to be limited in distribution, but grows near the summits of the Scottish mountains, and fruits in July and August.

Encalypta rhabdocarpa or the *rib-fruited extinguisher moss*, like the rest of the genus, has branched and radiculose stems, about half an inch long or rather more. Its leaves are moderately spreading, lanceolate or ovate-oblong, acuminate and

mucronate, or sometimes piliferous, concave, with a nerve thinner and paler than in *E. vulgaris*, generally excurrent, but sometimes ceasing below the apex. The capsule is of an oblong form, striated, somewhat apophysate, ribbed and strongly furrowed when dry; the broad, longitudinal, coloured striæ distinguishing it from all others. The fruit-stalk is red and twists towards the right. The calyptra is conico-campanulate, yellowish, scabrous or rugged at the apex, and slightly jagged or uneven at the base. The annulus is simple and the peristome persistent, consisting of sixteen lanceolate, firm, transversely barred teeth, which are sometimes marked with a medial line, as if to show them to be double. They are inserted below the orifice of the capsule, and their position is erect when dry. The vaginula resembles that of *E. vulgaris*, with its little crown arising from the same cause; but the calyptra of *rhabdocarpa* is shorter, wider, and of a darker hue, the leaves more acute and tapering, and the fruiting season is July and August; its habitats, the Scotch mountains, and Ben Bulben, Ireland.

The only remaining British species is the spiral-fruited *extinguisher moss*, *Encalypta streptocarpa*, whose inflorescence, unlike the other species, is dioicous. In this the elongated stems, from one to two inches long, or even more, are still branched and radiculose. It grows in shady situations, on limestone or mortared walls, etc., sometimes on chalky banks, or on a marly soil, often in extensive patches, but is rarely found in fruit. The walls of a bridge near Dunkeld are mentioned as one of its fruiting habitats. It has also been found in various localities in Derbyshire, and near Bolton Bridge in Yorkshire. It fruits in the month of August.

From its great length of stem, compared with the other members of the genus, one of our muscologists named it *Encalypta grandis*, but *streptocarpa*, from στρεπτὸς, writhed, twisted, or twined, and καρπὸς, fruit, is far too graphic to be superseded by any other, its sub-cylindrical capsule being, when ripe and dry, marked with eight or nine spiral furrows, and ultimately twisted in the same direction towards the left. It has a compound, dehiscent annulus, and a double peristome, inserted very little below the orifice, the outer one consisting of sixteen long, narrow, nearly filiform, nodulose teeth, almost half as long as the capsule, marked with a medial line, and confluent at the base. They are of a purplish red, and erect, but slightly reflexed when dry. The inner peristome is formed of yellowish-brown ciliæ, which alternate with the outer teeth, are about half their length, adhere closely to them, and unite in their lower half into a plicated membrane. The spores are small and smooth, the barren-flowered plants more

slender than the fertile ones, their flowers gemmiform and terminal.

The leaves are sub-erect, ligulate, or strap-shaped, obtuse and cuculate or hooded, at the apex, slightly crisped, or twisted when dry, with a purplish nerve ceasing at or near the apex; the upper leaves of a light green, the lower brownish, the perichætial leaves approaching to obovate at the base, lanceolate subulate above, and erect.

The calyptra is longer than in most of the species, sub-cylindrical, rostellate, approaching to subulate, rough and spinulose at the apex, lacinated, at first somewhat fringed at the base, of a yellowish brown colour, and coriaceous consistence. Its lacinated base arising from the same cause as that of *E. ciliata, i. e.*, from the spongy tissue crowning the vaginula, and which being of less firm consistence than the calyptra is torn away with it.

The spiral ribs of the capsule are more deeply coloured, and are of firmer texture than the interstices between them.

Thus we have attempted to describe all the hitherto known British species of this well-marked and interesting genus; and we trust that in so doing, we shall have furnished work for some microscopes, and pleasure for their possessors.

OUR ATMOSPHERE AND THE ETHER OF SPACE.

In the Intellectual Observer, vol. ii. p. 408, we laid before our readers the views of M. Quetelet concerning the great probable height of our atmosphere, and its division into two parts, the lower one being the seat of much movement and agitation, the upper portion being extremely light, stable, and probably of different chemical composition. In *Cosmos* (18th Feb., 1864) we find the following report of remarks on this subject by Father Secchi the Roman astronomer:—

"The shooting stars observed at Rome years ago, with the aid of the telegraph, have given an approximative estimate of height of eighty kilomètres at the least.* That indicates a much greater height of the atmosphere than is ordinarily supposed. But what is the composition of this atmosphere? That is impossible to define. The phenomena of ordinary electricity carefully studied at the time of auroras may afford us some light. I am of opinion that the idea, which is beginning to be accepted, that auroras depend upon discharges of atmospheric electricity in elevated regions is correct, and if so it will be very interesting to determine the

* The kilomètre is rather more than six-tenths of a mile (0·6314).

height of this meteor as seen from neighbouring places, and using the telegraph as an aid."

Cosmos also gives a letter from M. Hansteen of Christiana, to M. Quetelet, in which he says:—"Your last article on shooting stars and their place of appearance, has particularly interested me, on account of the idea put forth by you and approved by Sir John Herschel, H. A. Newton, and Aug. de la Rive, that beyond the lower atmosphere in which we live—and which you call the unstable atmosphere — there exists a second atmosphere three times as high—and which you term the stable atmosphere—of different composition, much lighter, and therefore, so to say, more igneous. It is only in this latter atmosphere that auroras manifest their luminosity. The upper atmosphere in which auroras and shooting stars appear as luminous bodies, may be nothing else than a very rarified hydrogen, very light and very inflammable. The period of revolution of Encke's comet, which diminishes one-tenth of a day at each revolution, suggests the existence of a resisting medium, which is accounted for by supposing the presence of a certain ether, the nature of which is unknown. May not this ether be very rarified hydrogen diffused through space."

The suggestions of M. Hansteen, though interesting, are open to certain objections. Why does he imagine the upper atmosphere to consist of hydrogen? Is it simply because that is the lightest body we are acquainted with on the surface of our globe? There is no reason whatever to suppose that the lightest body we know must resemble in composition, or be identical with, any lighter body that may exist somewhere else under totally different conditions. Nor is there any reason for supposing that the inflammability of hydrogen would be augmented by enormous rarefaction.

When a body is called inflammable we should remember that the term is not very precise.

It is customary to speak of certain bodies as being either combustible, or supporters of combustion; but the following remarks of Professor Miller place this subject in a clear light and show how easily the terms become convertible. He tells us* that "a striking experiment may be performed with hydrogen, which shows how purely conventional are the terms 'combustible' and 'supporters of combustion.' Let a tall bottle with a narrow neck be filled with hydrogen gas; through a cork which passes easily into the neck of the bottle, fit a jet connected with a gas-holder containing oxygen; place the bottle mouth downwards and set fire to the hydrogen, then immediately insert the cork and jet through which a stream of

* *Elements of Chemistry*, Part II. p. 48. Second edition.

oxygen is gently issuing. The flame will appear to attach itself to the oxygen tube, and the jet of oxygen will be burning in an atmosphere of hydrogen. Combustion in fact occurs at the place where the two gases first came into contact. Suppose for a moment that the earth's atmosphere had contained hydrogen instead of oxygen; oxygen would have appeared to us in the light of a combustible gas; hydrogen in that of a supporter of combustion."

The term "more igneous" may not be intelligible without considering the sense in which Sir John Herschel employed it, in the letter to M. Quetelet, from which M. Hansteen adopted it. Sir John said, that the great elevation of shooting stars above the earth "leads to the conjecture of an upper aerial atmosphere, lighter and so to say more *igneous*." Mr. Alexander Herschel has provided us with some remarks on this subject. He observes, "that according to the calculations of Thompson and Joule a body moving with a velocity of thirty-nine miles per second will heat the air, of whatever density, in immediate contact with it, two million degrees. Surely such velocities are more likely to exist in the highest and thinnest strata of the atmosphere, than in the lower denser parts, where storms and clouds, etc., are prepared, and in this sense the upper atmosphere may be called the igneous atmosphere, because it is more exposed to such igneous catastrophes from which the lower strata is happily defended."

If we consider the effects of heat and pressure in modifying the condition of matter, it will appear probable that there are limits to the existence of compounds having definite properties, both in a pressure range and a temperature range —that is to say, that no compound could be heated, or cooled, beyond a certain point without its becoming decomposed, or having its particles re-arranged into a new substance. And also that no compound could be condensed, or rarified, beyond certain limits without undergoing decomposition or change.

The grounds for conceiving the earth's atmosphere to be only forty or fifty miles high were incomplete. It was supposed that at about that distance from the earth the elasticity of the air and the force of gravity balanced each other. M. Quetelet now shows reason for believing that an upper atmosphere exists, and he assigns to it a different composition. May it not result from a resolution of the earth's lower atmosphere into some other form of matter? Oxygen and nitrogen may be compound bodies, and may be decomposed under such remarkable conditions of temperature, pressure, etc. Even if we regard them as simple substances, we have no right to limit their capacity for existing under different conditions, and with very different properties. The difficulty of defining a species

XUM

extends to chemistry, and it is far from easy to say what constitutes oxygen, for example. In zoology the idea of hereditariness, or common descent, comes into the species idea; in chemistry identity of constitution and properties is sufficient. But is ozone identical in constitution with oxygen, of which it is called an allotropic form? If M. Soret is right* in affirming that it is composed of a plurality of oxygen atoms arranged in a particular way, we must be either prepared to regard it as another substance, or to deny that the mode in which atoms are aggregated and the special properties thus developed, give rise to different species of substances. It may be said that ozone is not after all sufficiently unlike oxygen to require a separate name; but what of antozone? Schönbein considers that when one portion of oxygen is converted into ozone another portion passes into the state of antozone, which differs in properties from ordinary oxygen and from ozone. Antozone and ozone he considers in opposite polar conditions, and that when they come together they neutralize each other and produce ordinary oxygen. If so they act like distinct and different substances, exhibiting an affinity for each other.

M. Hansteen's supposition that the ether, or fluid conceived to exist in space, is like the upper atmosphere of our earth is worth consideration; but if so, that upper atmosphere must be capable of the requisite attenuation without being changed into another substance. Is it not a more probable supposition that however slowly the process may take place, all the bodies that swim in space contribute to the space atmosphere or ether, which would thus be composed of the most volatile and attenuated forms the materials of the various globes can assume when their normal cohesive and affinity forces are diminished or over-balanced by repulsive forces or new affinities?

Does it not seem improbable that each globe should retain for ever all the particles that it started with? Is not a circulation of matter more consonant with analogy? Why should the space atmosphere not only be added to, but taken from? Can our sun and all other suns be burning, or condensing it? The enormous temperature usually assigned to the solar photosphere may dissociate ordinary compounds, and develope powerful affinities between photosphere matter and the space atmosphere, and if it condensed millions of cubic miles with sufficient volocity, enormous heat would be produced.

With reference to the ether, or space atmosphere, it may be observed that the quantity of matter which is contained in a given volume of it, *may* not afford any measure of its resistance to planetary motion. In a paper on molecular mechanics, by the Rev. Joseph Bayma, published in the *Proceedings of the*

* See INTELLECUAL OBSERVER, vol. iv. p. 308.

Royal Society, No. 16, that gentleman affirms that "if a body does not contain any repulsive elements, it cannot cause any retardation in the movement of an impinging body;" and other reasons might be assigned to account for the small retardation of moving bodies without assuming a tenuity calculated from the known properties of atmospheric air.

Mr. Bayma's theory is not the only one that might account for the resistance offered by the space-atmosphere to a moving body, not being proportionate to the actual quantity of matter contained in a given bulk of it. What is called *vis inertia* is not, as we have remarked in another paper, simply do-nothingness, but the result of active forces, one of which is gravitation, and we have certainly no right to assume that gravitation is an attribute or property of matter under *all* conditions. It may be one of an unknown number of correlative forces, and the force which acts as gravitation under one set of conditions, may appear in another character when the conditions are changed.

These speculations may be dreams and nothing more; but a little dreaming is good for scientific progress, provided the process of dreaming is not vainly conceived to be a process of proof.

As our object in publishing these conjectures is to stimulate thought and inquiry, we will either print *in extenso*, or give an account of any important communications we may receive on any of the points discussed.

ANCHORING MOLLUSKS.

BY W. NEWTON MACCARTNEY,

Cor. Secretary Glasgow Naturalists' Society.

At the end of the last century the rage for conchology reached its climax, and then slowly declined. In its place the study of malacology engrossed the attention of many of those who had only gathered shells for the beauty of their form and the brightness of their colours. The possession of a cabinet of shells fifty years ago (and in many cases, even now) did not bestow upon the owner any knowledge of their structure or habits, and it was only when he gathered, observed, and dissected that he gained that essential knowledge which, while benefiting himself, would help the progress of the science. The shell to the conchologist may be of interest, but the animal which inhabits the shell will give a more enduring pleasure to the malacologist who studies its structure and observes its habits.

During the rage of shell-collecting, when a *Carinaria*

brought 100 guineas, and *Conus gloria-maris* half that sum, the parts of the animal which are the subject of this paper could not be studied, as, invariably before they were passed into the cabinet of the shell collector, they were cleaned from the specimen. However, in our times, when the animal is studied, as well as the shell admired, these organs by which the animal anchors itself may without difficulty be examined, and cannot fail to interest the observer.

The byssus of the mussel, and the pedicle of the lamp-shells, are considered to be of little, if any, importance in their study, and consequently not being much examined, some little things require to be explained, and some misapprehensions cleared away.

The importance of the cables in both these classes of mollusca, cannot be over-estimated by the palæontologist; for, in his explorations, he often disentombs large numbers of *brachiopoda* which have lived and died on the spot where he finds them. He is disposed to wonder why such quantities have gathered together, and it is only when he finds them to belong to the class of shells which anchor themselves to the sea-bottom that his amazement ceases. They can by means of their pedicle resist the scattering tendencies of the waves, and not being disturbed, the places where they have taken up their abode becomes densely populated, while spots not very far distant cannot boast a specimen. To the naturalists the knowledge of the mussel's habits sufficiently explain the colonies of them which occur in places suitable for their development.

During the geologic ages the lampshells, or *Terebratulidæ*, existed in great numbers, and in many cases the opening by which the pedicle protruded is distinctly visible. Then, as now, they attached themselves to rocks, stones, branches of corals, and every "coigne of vantage," and there hung freely suspended, swaying to and fro with the pulsations of the mighty ocean. In our still and deep lochs they are often brought up in the dredge, and if the locality is suitable, that is, of a calcareous silt, or muddy bottom, every small stone, or large shell, will have these little lampshells clinging to it. These shells are now but meagrely represented, when we consider the immense multitudes which swarmed in the seas during the deposition of the carboniferous limestone. There the sepulchres of countless thousands belonging to many species may be opened in every quarry.

The mussel, by means of its byssus, is able to remain secure on rocky coasts, where otherwise it would be dashed to pieces by the first rude storm. The fisherman, who uses them for bait, chooses a calm summer's day to place upon his new mussel farm the boat-load which he has forced to emigrate to "pastures

new." He knows that stormy weather would result in his emigrants being driven on shore; so he chooses his time, that the mussels may spin their cable and anchor securely. The owner of piers also requires to tend the crop of mussel carefully, so that they may cover the wooden piles, and thus protect them from the attacks of the boring shells. Some people think that they are useless on the wooden piers, and consequently scrape them off, considering that they destroy the piles, and eat into the wood.

Let it not be understood that the pedicle of the lampshell and the byssus of the mussel perform the same function. The pedicle, like the byssus, anchors the shell, but, unlike the byssus, assists the pedicle in closing and opening the shell. It is a fleshy cable, composed of fibres which are contractile. This cable is attached at one end to the stone by a kind of glutinous substance, and at the other to the upper or ventral valve. Within a little distance from the foramen, or little hole through which it passes into the shell, muscles are attached. These join on to the pedicle near to the point of emergence, and are also attached to the dorsal valve by the other end. The hinge of the shell is at the foramen. When the animal is at rest, and not disturbed, the pedicle is uncontracted, and the shell open. The cable being at its longest range, allows the shell to hang free, and to have a pretty wide range; but whenever danger approaches instantly the pedicle contracts, the shell by that action shuts, and at the same time darts backward a little towards its anchorage, out of the way of the intruder. The pedicle contracts, and the muscles which are attached to the pedicle contract at the same moment, and the shell is fast closed, to be opened when danger is past.

In the mussel the byssus acts no part similar to this. When once it is spun it is lifeless. The visitor to the seashore will find that it is made up of a great many small threads, which have taken a very firm hold. These are connected with the interior of the shell, and are extremely strong. The question suggests itself, how are these threads spun, and how do they fasten to the rock? The mussel has no spinnarets like the spider or the silkworm. That there is a sticky secretion no one can doubt; but of what it is composed, and how it is secreted, is yet to be discovered. A Glasgow naturalist has observed the process of placing the cable, which may be briefly described. The foot was protruded, fat and fleshy, and touching the side of a glass jar, it remained for a time in contact. After withdrawal nothing was noticed for a moment, but then slowly a little thread became visible, and the first thread of the cable was laid, which was followed by another, and another, as the foot touched the side of the glass. There must, we think,

be a secreting surface either in the foot or easy of access to it; and that secretion hardens and blackens by exposure to the water. The threads are attached to the shell, and have no connection with the internal economy of the animal. The byssus spun by the *Pinna* has been used with silk, and spun into some articles of dress. That of the great horse-mussel is exceedingly fine, and if it could be obtained in sufficient abundance might be used in commerce.

In conclusion, could not a series of experiments be made on the mussel (*Mytilus edulis*), to discover how it spins its cable, and where it gets the material? By discovering this, we could then with certainty understand how the Lima and other shells make their nest, for they also use silken fibres to bind the materials of which their house is built.

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. F. CHAMBERS.

(*Continued from page* 384, *vol.* iv.)

663. On September 27 a comet 2° long was seen near ζ Boötis. On September 29 it had disappeared.—(Ma-tuan-lin.)

667. On May 24 a comet was seen in the N.E., between Auriga, the Pleiades, and Taurus.—(Gaubil.) On June 12 it disappeared.—(Ma-tuan-lin.)

668. In May or June a comet was seen for a few days in Auriga.—(De Mailla, vi. 145.) Is it certain that this comet differs from the preceding?—(Pingré, i. 331.)

676. [i.] On January 4 a comet 5° long was discovered to the S. of α and ζ Virginis.—(Ma-tuan-lin.)

676. [ii.] "In the month of August a comet showed itself in the E. for three months, from the time of cock-crowing till morning. Its rays penetrated the heavens; all nations beheld with admiration its rising; at length, returning upon itself, it disappeared."—(Anastas, *Historia Ecclesiastica;* Paul Diacon. v. 31.) On September 4 a comet appeared near to α and β Geminorum; it moved towards the N.E. Its tail, at first 3° long, afterwards increased to 30°, and pointed towards λ and μ Ursæ Majoris. On November 1 it had disappeared.—(Ma-tuan-lin; Gaubil.)

681. On October 17 a comet 50° long was seen near *a* Herculis; gradually diminishing in size it moved towards *a* Aquilæ, and disappeared on November 3.—(Gaubil.)

683. On April 20 a comet was seen near *α* Aurigæ. On May 15 it had disappeared.—(Ma-tuoan-lin.)

684 [i.] On September 6 a comet 10° was seen long in the evening towards the W. On October 9 it had disappeared.—(Gaubil.) Hind remarks that this single account will tolerably well describe the position which *Halley's comet* must have been in at its return to perihelion in this year; so, doubtless, this was that celebrated body.—(*Comp. to Almanac*, 1860, p. 88.)

684 [ii.] On November 11 a star like a half-moon was seen in the N.—Ma-tuoan-lin.

707. On November 16 a comet appeared in the W.; on December 18 it had ceased to be visible.—(Ma-tuoan-lin.)

708. [i.] On March 31 a comet appeared between the Pleiades and Musca.—(Ma-tuoan-lin.)

708. [ii.] On September 21 a comet appeared within the circle of perpetual apparition.—(Ma-tuoan-lin.)

711. In the 92nd year of the Hegira a comet endued with a sensible motion appeared for eleven days.—(Haly. *Liber Ptolemœi Comment.*) The year 92 of the Hegira lasted from 710, Oct. 29, to 711, Oct. 18.

712. In August a comet emerged from the W., and passed to near *β* Leonis, etc.—(De Mailla, vi. 199.)

716. A comet of a terrible aspect, with its tail directed towards the Pole, is said to been seen this year, but we have only a modern authority for the statement.—(Sabellicus, *Omnia Opera*, Ennead. viii. lib. vii., Basileæ, 1560.)

729. Several writers speak of two comets visible for fourteen days in the month of January, the one after sunset and the other before sunrise.—(Bede, *Historia Ecclesiastica*, v.; Herveld, *Chronicon Historiæ Germanicæ*.) It is easy to see that a single comet with a Right Ascension not differing much from that of the Sun, but with a high North Declination, would be seen both after sunset and before sunrise, and thus fulfil the statement of the chroniclers. Donati's great comet of 1858 was so visible for several weeks in the month of September of that year.

730. On August 29 a comet was seen in Auriga; on September 7 it spread its light over the Hyades and Pleiades.—(Gaubil.) Ma-tuoan-lin says that the comet of September 7 was not the same as that of August 29.

738. On April 1 a comet was seen within the circle of perpetual apparition. It traversed the square of Ursa Major, and was observed for ten days or more, when clouds interfered.—(Ma-tuoan-lin.)

744. A great comet was seen in Syria.—(Theophanes, p. 353.)

762. A comet was seen in the E. like unto a beam.—(Theophanes, p. 363.)

767. On January 22 a comet 1° long was seen near α and β Delphini. It was visible for three weeks.—(Ma-tuoan-lin.)

773. On January 17 a great star appeared below the belt of Orion.—(Ma-tuoan-lin.)

813. "On August 4 a comet was seen, which resembled two moons joined together; they separated, and having taken different forms, at length appeared like a man without a head." —(Theophanes, p. 423.) In spite of the strangeness of this description, Pingré considers it to be really that of a comet, and thinks it is possible to find an explanation in the comet's peculiar position with regard to the Sun and the Earth.—(*Comèt.* i. 338.)

815. In April or May a great comet appeared in the vicinity of β Leonis.—(Ma-tuoan-lin.)

817. On February 5, at the second hour of the night, a monstrous comet was seen in Sagittarius.—(*Vita Ludovici Pii.*) On February 17 the comet was in the Hyades.—(Ma-tuoan-lin.)

821 [i.] On February 27 a comet was seen in Crater. On March 7 it was near σ Leonis.—(Ma-tuoan-lin.)

821 [ii.] In July a comet with a tail 10° long was seen in the Pleiades. After ten days it disappeared.—(Ma-tuoan-lin.)

828. On September 3 a comet with a tail 2° long was seen near η Boötis.—(Ma-tuoan-lin.)

834. On October 9 a comet with a tail 10° long was seen near β Leonis. It went northwards beyond Coma Berenicis. On September 7 it had disappeared.—(Ma-tuoan-lin.)

837 [ii.] On September 10 a comet was seen in Aquarius. —(Ma-tuoan-lin; Boëthius, *Scotorum Historia*, x.)

838 [i.] On November 11 a comet was seen near β Corvi. —(Ma-tuoan-lin.)

838 [ii.] On November 21 a comet was seen in the E. in the sidereal divisions γ Sagittarius, and μ^2 Scorpio. It extended in the heavens E. and W.; on December 28 it had disappeared.—(Ma-tuoan-lin.)

839 [i.] On January 1 a comet was seen in Aries.—(*Annales Francorum Fuldenses.*) On February 7 a comet was seen near χ Aquarii.—(Ma-tuoan-lin.) Pingré thinks the latter could not have been the European comet of January 1.—(*Comèt.* i. 614.)

839 [ii.] On March 12 a comet was seen to the N. of ν, ϵ, ξ, ζ Persei. On April 14 it had disappeared.—(Ma-tuoan-lin.)

840 [i.] On March 20 a comet was seen between the sidereal divisions of α and γ Pegasi. After three weeks it disappeared.—(Ma-tuoan-lin.)

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

STATISTICAL SOCIETY.—*Feb.* 16.

Effects of Open-air Exercise on Longevity.—In a very elaborate paper on the reports of the Registrar-General, Mr. Sargant brought forward some remarkable facts, showing the influence of out-door occupation and exercise in lessening the rate of mortality; and that of almost all in-door occupations, long continued, in raising the rate of mortality of the classes following them.

The greater longevity of persons living in the country appears almost wholly due to the greater proportion of out-door occupation; inasmuch as shopkeepers and others following sedentary pursuits in the country have no well-marked vital superiority over the same classes in towns; whereas farm labourers, though exposed to the effects of wet, attain a greater longevity than any class of mechanics working in a confined atmosphere.

Even scavengers in towns, who are exposed to very great impurities, are long-lived, owing to the vital influence of the open air in which they follow their occupation.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.—*Feb.* 23.

Preparation of Calcium.—A paper was communicated by Mr. E. Sonstadt on the preparation of the metal Calcium. After describing the well-known difficulties which have hitherto prevented calcium being prepared except in very small quantity, Mr. Sonstadt described his new process, which consists in fusing together iodide of potassium and chloride of calcium. The mixture, whilst still liquid, is poured into an iron crucible and permitted to solidify. The mass is then thrown out, and rather less than an equivalent proportion of sodium placed in the bottom of the crucible; the solid mixture of potassium and calcium salts being replaced above it. The cover is then closely luted on, and the crucible heated to redness for a short time. The reaction that ensues is not violent, and the calcium remains in the crucible in a solid mass.

At the same meeting the practical advantage arising from the improvements of Mr. Sonstadt in the manufacture of the metal Magnesium were shown. Ten grains of magnesium wire were burnt, giving a light which lasted for one minute, during which time an

excellent negative photograph of a bust by Chantrey was taken by Mr. Brothers.

The photographs produced by magnesium light are of a very agreeable character; and as the amount of metal required is very small, the process is not expensive, and it is probable that it may come into general use.

GEOLOGICAL SOCIETY OF LONDON.—*Feb.* 19.

Succession of British Mesozoic Strata.—The President in his anniversary address discussed the breaks in the succession of the British Mesozoic Strata. First, he examined the numerical relations which different classes bore to one another in Palæozoic times, comparing them with their development in secondary epochs. The general conclusion arrived at was that a long interval of time, often stratigraphically unrepresented, is an invariable accompaniment of a break in the succession of species; and the more special inference was that, in cases of superposition, in proportion as the species are more or less continuous, that is to say, as the break in life is partial or complete, first in the species, but more importantly in the loss of old and the appearance of new genera, so was the interval of time shorter or longer that elapsed between the close of the lower and the commencement of the upper formation.

Feb. 24.

Recent Discoveries of Flint Implements in Drift Deposits in Hants and Wilts.—Flint implements having recently been found on the sea-shore, about midway between Southampton and Gosport, and also at Fisherton near Salisbury, Mr. J. Evans visited these localities in company with Mr. Prestwich, and gave the results of his observations.

After describing the implements from near Southampton, and having shown that their condition is identical with that of the materials composing the gravel capping the adjacent cliff, Mr. Evans maintained the great antiquity of these remains, as proved by the circumstance that the gravel-beds, like those of Reculver, are of fluviatile origin, although now abutting on the sea.

Mr. Evans then described the Fisherton implements, and the gravel-pits from which they were obtained. The relation of the high-level gravels (in which the implements were found) to the lower-level gravels of the Valley of the Avon was discussed, and the geological features of the former deposits particularly described; lists of the fossils (including the mammalia and the land and freshwater shells) being also given. Mr. Evans came to the conclusion that the fossils bore evidence of the climate, at the time when they were deposited, having been more rigorous, at any rate in the winter, than it now is; and to this cause he attributed the comparatively greater excavating power of the early Post-pliocene rivers.

March 9.

On the Discovery of the Scales of Pteraspis.—Mr. E. R. Lankester communicated a paper on the Pteraspis, in which the suc-

cessive steps by which the genus was established, and the grounds on which the prevalent opinion as to its ichthyic nature rests, were noticed. The author then proceeded to describe the scales, which have lately being discovered at Cradley, near Malvern, and which alone were required to remove all doubt as to the affinities of the genus: he compared these scales with those of *Cephalaspis*, to some of which they bear a great resemblance.

ANTHROPOLOGICAL SOCIETY.—*March* 1.

THE THEORY OF NATURAL SELECTION AS APPLIED TO THE HUMAN RACES.—In a paper on this subject Mr. Wallace maintained that the theory of natural selection, as influenced by physical structure, could not be applied to explain the origin of the different races of men in the same manner as it could be employed to account for the origin of varieties and species in the lower animals.

In animals a deficiency of any one organ or faculty would of necessity lead to the destruction of the race in the struggle for life. But in man any such deficiency may be supplied by means of the division of labour, by which an individual unfitted for one occupation could follow another; and also by the assistance and sympathy which always existed even in the lowest races of mankind. Moreover, by the formation and use of artificial weapons mankind can compensate for any deficiency in strength or agility.

These causes acting conjointly remove man from the influence of "natural selection," as far as regards his physical structure; but its action is transferred to the mind. Those races with the highest intellectual endowments, capable of the greatest amount of organization, and the fabrication of the most efficient arms, would of necessity overcome and eventually extirpate the inferior races. Hence it was argued that the possession of an intelligent mind removed mankind from the operation of the laws of natural selection; consequently his physical structure remained unchanged, except as far as regards slight and accidental variations.

It was shown that this theory harmonized many of the hitherto conflicting views of anthropologists, by demonstrating why races have so long remained unchanged, and are apparently unchangeable. At the same time, it offers no opposition to the generally received opinion of the unity of the human race.

ROYAL INSTITUTION.—*March* 4.

THE DISCRIMINATION OF ORGANIC BODIES BY THEIR OPTICAL PROPERTIES.—In a lecture on the detection of organic bodies by means of their spectra, Prof. Stokes showed an exceedingly simple and practical mode of distinguishing between substances of similar appearance. The solution of the body to be examined is placed in a test-tube, behind a slit in a small opaque board; light is allowed to pass through the tube, which is looked at with a small prism, used with the naked eye, when the characteristic appearance of the substance

is at once evident. In this manner solutions of blood and of port wine of equal intensity of colour are capable of being instantly distinguished from each other.

Prof. Stokes has applied this test to the green colouring matter of the bile, supposed by Berzelius to be identical with chlorophyll, and has discovered that it is perfectly distinct. Chlorophyll yields solutions in alcohol, ether, etc., which are characterized by very strongly marked bands of absorption, that are wholly absent in the solutions of the colouring matter of the bile, which has been named Biliverdin. There is no doubt but that the easy and practical mode of discrimination designed by Prof. Stokes will be of very great value to the working chemist and medical jurist in the distinction of organic substances of nearly similar appearance.

ARCHÆOLOGICAL INSTITUTE.—*March* 4.

ANCIENT HABITATIONS IN ANGLESEA.—The Honourable W. O. Stanley communicated a very interesting account of the remarkable circular habitations found in Anglesea, being particularly abundant in the neighbourhood of Holyhead. These habitations, which are usually from 15 to 20 feet in diameter, are designated as *Cuttier Gwyddelod*, or the Irishmen's huts, in the maps of the Ordnance Survey; there appears, however, but little doubt that the title is an erroneous one.

Each habitation is formed of turf, with two stones forming the sides of the entrance; these are often found standing in the erect position. A detailed description was given of the opening by Mr. Stanley and Mr. Albert Way of a village consisting of upwards of one hundred houses, standing on a terrace about six hundred yards in length from north-east to south-west. On this terrace the houses were placed close together, but without any regularity or plan, except that the openings were almost always turned towards the south-east.

A very early age was assigned to these dwellings by the author of the paper, who regarded them as having being constructed before the use of iron or other metals was known in the locality. He thought therefore that they must have been erected by the aborigines long before the invasion of the Romans; and not, as their popular name implies, by immigrants from Ireland.

Mr. Morgan stated that dwellings of a precisely similar character existed in Monmouthshire, which certainly were not the work of Irish invaders.

NOTES AND MEMORANDA.

GERMS OF INFUSORIA.—M. le Vicomte Gaston d'Auvray has addressed a letter to the French Academy, stating that by means of an apparatus, which he calls a *dialyser*, he filters water or other liquid so as to separate and collect the germs of Infusoria. He finds two sorts of germs, greenish grey and pearly white. He says they exist in all water, even when distilled, although most plentiful in that which is impure. In air he also finds them, and they abounded in the thick fog of 2nd of December, 1863. All the grey germs are spherical, varying in diameter from $0^{mm}.00024$ and $0^{mm},00034$. The pearl white corpuscles are of three sorts: A and B spherical, their diameter being $0^{mm},00040$ and $0^{mm},00065$; C are ovoid, with lesser axis, $0^{mm},00065$, and major axis $0^{mm},00080$. The grey corpuscles he calls germs of protophytes; the white, of animalcules, among which he includes vibrions. If the corpuscles are all removed from water, but the debris of organic matter, such as bits of textile fabrics, vegetable epiderm, pollen grains, butterfly scales, smoke particles, allowed to remain in a flask which is sealed hermetically, no life is developed, and the result is negative if some white of the white corpuscles are added. If however some of the greenish grey corpuscles are added, first protophytes, then amœbæ, monads, and vibrions appear. If into these flasks containing the grey corpuscles, the white ones, A, B, and C are added, A yields amœbæ, B monads, and C vibrions. M. d'Auvray states that he is preparing a work on this subject, and when the details are known his experiments can be checked by other observers. One of his most remarkable statements that demand verification, that some germs are able to withstand strong acids, prolonged boiling, or attempts at calcination, by passing the air containing them through red hot tubes.

COLLINS' BINOCULAR MICROSCOPE.—This is a large, handsome instrument, presenting some novel and ingenious peculiarities. It carries two object-glasses on a dovetailed arm, sliding in a groove, so that a change of powers can be instantly made. We should think this mode of construction would require even greater attention to accuracy than the ordinary double nose-piece; but, if accurately centered, it affords certain advantages. The next important speciality is the facility with which the polarizer (carried under the stage) can be brought into play, and the analyser made to replace the prism of the binocular arrangement, by drawing in or out the slide which carries both. In certain chemical and medical investigations, these arrangements are very convenient, and several eminent members of the medical profession have expressed great satisfaction with Mr. Collins' labours.

The stage is furnished with a magnetic bar, and if likewise supplied with the ordinary object-holder and clip, its range of utility would be increased, as the magnetic plan, though good for slides, is not well adapted for heavier articles like zoophyte troughs. We carefully examined the optical part of one of these instruments and found it fully equal to all ordinary requirements. Mr. Collins has taken an honourable place amongst those opticians who offer students a great deal of convenience for a small sum of money. In first-rate, costly instruments all kinds of wants are provided for; but where price is an object, the purchaser must consider what he stands most in need of, and what he can best dispense with. Under such circumstances tastes and necessities will lead to much difference of opinion, but it would be admitted on all sides, that Mr. Collins' binocular is well entitled to consideration, and likely to meet the wishes of a large class.

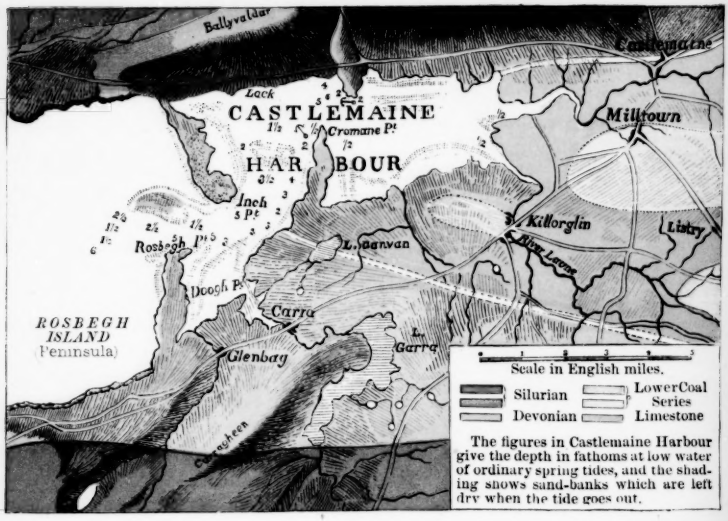
NEW SOURCE OF POTASH.—A coral-red subtranslucent mineral, reported to have been obtained from Cheshire, has been submitted to analysis by Professor Church. He has identified it with the carnallite of M. H. Rose; it contained 25·7 per cent. of chloride of potassium. It is most probable that this rich source of potash overlies the rock-salt beds of this country as well as those of the foreign localities where carnallite has been found. It has been suggested that it was formed in the *last* stages of the drying up of ancient seas.

PERMEABILITY OF METALS AT HIGH TEMPERATURES.—M. L. Cailletet has made the following communication to the French Academy. After remarking upon the facts mentioned by MM. H. St. Claire Deville and Troost, who found that iron at a high temperature was completely permeable for oxygen, and that a tube, heated in a furnace, and filled with hydrogen, allowed that gas to escape so that a vacuum was formed, M. Cailletet proceeds to detail his own experiments. He says—"I passed portions of a gun-barrel through rollers till they were flattened. The ends were then welded (*soudées*). Thus rectangular pieces of iron were obtained, formed of two plates in contact, and sealed at their extremities. On strongly heating one of these pieces in a furnace, the non-welded portions separated, and resumed the cylindrical form and their original volume. It could not, therefore, be doubted that the gases of the furnace had penetrated the mass of iron and distended its walls." To a similar action Mr. Cailletet ascribes the cavities in large masses of forged iron; and he states that in the process of cementation, *acier poule*, or steel with vesicles, is constantly produced; but if soft, perferfectly homogeneous iron, such as can be obtained by keeping melted steel for several hours at a high temperature, be employed, it is reconverted into steel without blisters. M. H. St. Claire Deville remarks upon this communication that it is "very interesting and conclusive," and he adverts to the discharge of gas from molten matter often observed in metallurgical operations. These gases, he considers, penetrate the walls of the crucibles by endosmose, and give rise to bubbles in the metals.

ACTION OF PORCELAIN AND LAVAS AT HIGH TEMPERATURES ON GASES—POSSIBLE ACTION OF THE MOON.—M. Ch. St. Claire Deville makes allusion to the preceding facts, and states that his brother and M. Troost have shown that if hydrogen traverses without difficulty the walls of a porcelain tube at a high temperature, it does not do so when the tube begins to soften or vitrify. The gas is then absorbed by the vitrified surface, from whence it escapes, leaving it porous. He connects these facts with the appearance of certain lavas. He says the lavas of Vesuvius, whatever the rate of their cooling, are always crystalline, and that they disengage aqueous vapour, chlorides, sulphides, etc., as the crystallization proceeds, just as oxygen escapes from silver that takes the rocky form, or air escapes from freezing water. The crystallization of lavas he states to be accompanied by increase of density and evolution of heat. He traces a resemblance between the Campi Phlegræi and the surface of the moon, and considers that the latter may have behaved like eruptive matter with excess of silica, which has a tendency to consolidate in a vitreous form, and imprisons gaseous matter in its solidification.

M. VIAL'S PROCESS OF ENGRAVING.—The lines are drawn on steel with a fatty ink, or transferred to the steel, which is then plunged in a bath, saturated with sulphate of copper, and accidulated with nitric acid. In five minutes the plate is removed and washed; the copper is removed with ammonia, and the engraving is finished. The explanation is that the metallic solution deposits copper on those parts of the plate which are not covered with ink. This copper is removed by the final washing. The acid penetrates the ink slowly, and when this is accomplished a galvanic circuit is completed between the deposited copper and the steel, protected by the ink from the simple deposition. The steel becomes the positive pole, and is attacked by the sulphuric acid liberated from the copper by the free nitric acid. M. Vial states that this action is strongest where the ink is thickest, and that lines are thus etched of the proper depth and thickness. The copper that results from the electro-chemical decomposition is said to be thrown down on the borders of the lines, and to lift up the ink so as to form the pattern in raised copper, which is removed by the ammonia. The process was favourably reported on by a Commission of the French Academy; and when recently exhibited at the Society of Arts, some practical engravers present thought it would be adapted to the cheap and convenient reproduction of effects not requiring the aid of shading in cross lines.

XUM



Map of a small portion of the County of Kerry, showing the district in which the Natterjack Toad is found indigenous.

Natterjack Toad (Bufo Calamita) from Co. Kerry.